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Assessment of Emergency **Management Performance and** **Capability**

Work carried out under the supervision of
Professor J E Strutt

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Abstract

Hazardous industries in the UK and Europe are under pressure to increase the transparency and accountability of the ways in which they manage their hazards and the risks they pose to the population and environment. The literature has indicated that the field would benefit from a risk-based, continuous improvement approach to emergency management in hazardous industry.

The aim of this research was to construct a framework to enable assessment of the emergency management performance and capability within UK hazardous industry operators. Continuous improvement models from other fields were examined, and an established model called the Capability Maturity Model was selected to form the basis of the framework.

A three-stage data collection methodology was designed to gain an overview of an organisation's emergency management capability. This methodology involved reviewing a sample of emergency plans related to UK hazardous industrial sites and observing eight emergency exercises at major hazard industrial sites. The third stage was to record the learning capability of the organisation by observing their feedback processes and interviewing members of staff were necessary.

Analysis of the resulting data enabled the construction of a set of eight key processes that define an emergency management system. Using the five-level structure of the Capability Maturity Model along with the principals of continuous improvement, an emergency management assessment framework was constructed.

The assessment framework was successfully tested in a large Local Authority, using its emergency plan, a major exercise and a follow-up interview to collect the relevant information. The assessment provided clear details of current capability and maturity of the emergency management system, giving structured guidance on weaknesses in specific process areas and more generally in particular stages of the emergency management system. This ultimately enabled the Local Authority to focus its improvement efforts, increasing their efficiency in learning and effectiveness in preparedness and response.

Acknowledgements

This work would not have been possible without the support I have received from my family throughout the research – great thanks are due to mum, dad, Dan, Russ, Mal and especially Caroline for her tireless proof-reading. I am also grateful for the academic motivation and conviction found in my friend and mentor Colin Rae, and to MM Datta of the WHO for his inspirational dedication to work.

Academic guidance has often steered me back onto the narrow and rather perilous path to achieving this study, and for that supervision I would like to sincerely thank Professor JE Strutt. The encouragement from other corners of Cranfield has been outstanding, and those deserving particular mention are Professor Hartley, Sue Richardson, Dr Spurrier, David Buck and CDMC Shrivenham. The library and its staff were excellent, and the Cranfield Computer Centre gets one point for effort.

For their enthusiasm, expertise and backing throughout the research I am indebted to Rear Admiral Jeremy Larken DSO, and Helen Shannon of OCTO Ltd. Thanks also to their clients and contacts at BP, ICI, Shell, Urenco, Avecia, BNFL, the HSE and Transco. Additional gratitude to CCS at Easingwold, Bedfordshire County emergency planners, Cheshire, Surrey and Greater Manchester emergency planning departments.

I must also thank Les Moseley, Robin Tasker, Hazel and all at the Coventry University Centre for Disaster Management along with Dr Anne Eyre, for inspiring my academic curiosity and preparing me so well to study this challenging and fascinating subject. Sincere gratitude is also expressed to Professors Davis and Sharp, Dr Lemon and Ed Terry, and my expert review panel for their time and effort in providing the detailed validation feedback for this work.

Finally I must thank my friends. Shakespeare said “have few friends, but those thou hast, grapple them to thy heart with hoops of steel.” I abide by his advice, and those who are truly grappled are Al, Alistair, Em, Gemma, Jo-Anne, Laura, Lorna, Neil T, Neil F, Sarah, Tom & Gem and to Greg, for convincing me that the truth is in here, not out there.

**“Whosoever cultivates doubt can and must
resaddle the stallions of inquiry”**

(Beck 2001)

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Table of acronyms

Acronyms in small purple text are used specifically in the diagram of PCMM processes, Figure 6.4

Acronym	Full meaning of term
C	Compensation
C&C	Communications and coordination
CA	Competency Assessment
CACTUS	Command and Control Training using Knowledge based Simulations
CAMEO	Computer Aided Management of Emergency Operations (USA)
CBA	Competence Based Assets
CBP	Competency-based practices
CCI	Continuous capability improvement
CCRF	Civil Contingencies Reaction Force
CCS	Civil Contingencies Secretariat (Cabinet Office, UK)
CD	Career Development
CDMC	Cranfield Disaster Management Centre (UK)
CEM	Comprehensive Emergency Management (USA)
CI	Competency Integration
CIMAH	Control of Industrial Major Accident Hazards (pre-COMAH)
CMM	Capability Maturity Model
COMAH	Control of Major Accident Hazards (UK regulations, 1999)
CWI	Continuous workforce innovation
DEC	Deputy Emergency Controller
DEM	Deputy Emergency Manager
DOSEC	District Offsite Emergency Command
EA	Environment Agency (UK, regulator)
EC	Emergency Controller
ECC	Emergency Control Centre
EEC	European Economic Community (now EU)
EM	Emergency Management
EMPIRE	Emergency Management Performance Indicators and Risk Evaluation (framework)
EP	Emergency Plan
ES	Emergency Services (Fire, Police, Ambulance, Coastguard)
EU	European Union
EUREKA	European Union Research body
EW	Empowered workgroups
FCP	Forward Control Point
FEMA	Federal Emergency Management Agency (USA)
FMEA	Failure Modes and Effects Analysis
GDSS	Group Decision Support System
GEMA	Generic Emergency Management Assessment

Acronym	Full meaning of term
GIS	Geographic Information System
HASAW	Health and safety at work regulations (UK, 1974)
HSE	Health and Safety Executive (UK, regulator)
ICS	Incident Command System (USA)
IEM	Institute of Emergency Managers (Professional society, UK)
IEM	Integrated Emergency Management (UK)
IT	Information Technology
LA	Local Authority
<i>M</i>	Mentoring
MAHI	Major Accident Hazard Industry
MIC	Methyl Isocyanate
NAO	National Audit Office (UK)
NOAA	National Oceanic and Atmospheric Administration (USA)
<i>OCM</i>	Organisational capability management
OIM	Offshore Installation Manager
<i>OPA</i>	Organisational Performance alignment
<i>PC</i>	Participatory culture
PCMM	People Capability Maturity Model
<i>PM</i>	Performance management
PPE	Personal Protective Equipment
PSR	Pipeline Safety Regulations (UK, 1996)
PTS	Post Traumatic Stress
PTSD	Post Traumatic Stress Disorder
<i>QPM</i>	Quantitative performance management
QRA	Quantitative Risk Assessment
<i>S</i>	Staffing
SDSS	Spatial Decision Support System
SDT	Signal Detection Theory
SEI	Software Engineering Institute (University of Pittsburgh, USA)
SOP	Standard Operating Procedure
SWCMM	Software Capability Maturity Model
<i>T&D</i>	Training and development
TMI	Three Mile Island (USA nuclear power station)
UFOE	Uncontrolled Flow of Energy
UNDP	United Nations Development Programme
<i>WE</i>	Work Environment
<i>WFPI</i>	Workforce Planning
<i>WGD</i>	Workgroup development
WHO	World Health Organisation

Chapter 1

Introduction to the thesis

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The research sponsors were a company called OCTO, who drew from their extensive industrial experience in UK Hazardous Industry, and concluded that the demands on industry to manage incidents faster, more efficiently and more effectively were increasing. These demands were from Europe, the UK government and regulatory bodies. The core problem was that industry had no method of reasonably justifying their capability in emergency management. There was no benchmark they could aim for, which would prove that they were capable of dealing with their hazards.

The research supervisor added that while quantitative methods were available for assessing risk and performance of individual emergency tasks, there was no means of assessing the capability of the whole organisation. He suggested a literature search to see how capability is measured in the organisational management field. Cranfield University researchers had previously worked together to design a performance measurement system for the Health and Safety Executive, (Strutt et al. 2001) and so appreciated how capability could not be measured in the same way as performance, as it is a much wider and deeper organisational concept.

The researcher added that EMPIRE (Emergency Management Performance Indicators and Risk Evaluation) had focussed mainly on the physical attributes of the site and the arrangements for the emergency response. While these played an important role, the main focus of an organisational capability assessment would be the human parts of the system. As discussed in chapter 3 the literature search revealed that one of the most popular assessments of capability is the Capability Maturity Model, and this could form a robust foundation on which to base an emergency management capability model.

The following section takes a conceptual step back, to highlight some of the wider issues that support this research.

1.1.1 Why improve emergency management?

One of the core justifications for this research is that while there will always be accidents and injuries as a result of industrial activity, the response to these incidents is not as good as it potentially could be. The research sponsors cited a number of cases where organisations were satisfied that their emergency

1.1 *Introduction to Emergency Management Assessment*

The core purpose of this research is to provide a method of assessing emergency management performance and capability.

This chapter will present the case for the research through reasoning that begins with wider conceptual arguments, and focusses down to the objectives of the thesis. The chapter will conclude by briefly stating the researcher's learning objectives, and give details of the structure and features of the thesis.

This research began with a discussion between the research supervisor, the researcher and the research sponsors. The three parties contributed different aspects to the discussion, and it concluded with three main points.

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management met the regulatory standards. The regulators admitted that meeting their standards 'to the letter' represents the absolute minimum requirement for an operator to comply with the law, and does not represent best or even good practice. Daniell (2000) labels this concept as 'satisfactory underperformance', where an organisation is content to perform to a level which is below its potential performance standard.

The continual advance of technology has led to closer coupling between humans, technology and the environment. In these increasingly complex and interrelated systems, hazards are more difficult to manage and risks are more difficult to identify (Perrow 1999). Contemporary methods of emergency planning and management are less effective at keeping pace with the dynamic nature modern risk. This issue has been recognised by the European Union (EU). In 1999 the EU introduced the Europe-wide Seveso directives, translated in UK legislation as the Control of Major Accident Hazard (COMAH) regulations, to manage hazardous substances at storage and process sites. They are now introducing the Regulation, Evaluation and Authorisation of Chemicals directive (Institute of Chemical Engineers, 2003) which imposes risk assessment and risk management responsibility on all organisations that produce, import or use hazardous chemicals. The regulations will be phased in over the next 11 years, beginning with immediate effect for the most hazardous chemicals and persistent biological toxins.

Steed (1998: 152) also addresses this question in his thesis, stating that

"A new generation of emergency planners are emerging, who are not concerned with preparing for enemy attack, and a tradition of research on emergency behaviour is beginning to grow...This new generation of emergency planners will have the responsibility of demonstrating that the answers to the question 'Why plan for emergencies' are that it makes good economic sense, it is good management practice and it is what the community deserves and expects."

(Steed 1998: 152)

Steed's last line touches on the expectations of the community, which is an important issue. Steed is referring to the community in the sense of a local body of residents; however, the wider definition of community also applies. This study will refer to everyone with an interest in or concern with emergency management as a stakeholder. Stakeholders all have different expectations and requirements from hazardous industry, and in general terms, those requirements are becoming harder to meet. Communications advances allow pressure groups, the public and the media to be aware of any incident within minutes of it happening, and pictures can be broadcast live to the world from a mobile telephone, using the Internet. Business relationships and clients are increasingly working to shorter timescales, lower stock-holding and 'just-in-time' supply principals. Customers can demand that their suppliers meet certain accredited standards of reliability, quality and excellence, such as the ISO series.

There is no such method for demonstration or assurance of capability in UK hazardous emergency management.

1.1.2 Why should emergency management capability be assessed?

Major Accident Hazard Industry is already demanding assessment and recognition of their emergency management systems, and various consultancies in the UK are responding by providing their own assessment frameworks, the OCTAVE and EMPIRE frameworks offered by OCTO Ltd are examples. MAHI is also looking within to compare performance and share learning, with regional groups of Hazardous operators and emergency service representatives are functioning well in Grangemouth, Teesside and Cheshire.

The Institute of Emergency Management (Institute of Emergency Management 2003) is currently working on a proposal to create an accreditation scheme for emergency managers. Based on the system used in the USA, emergency managers would have to demonstrate competence and knowledge to be awarded a formal qualification, which would have to be maintained by refresher courses.

These indications from the field show that at the individual, organisational and inter-organisation levels, emergency management comparison and improvement are becoming increasingly important to industry. The same situation is arising in Local Authority emergency planning departments, which are increasingly reaching the highest levels of business performance standards (Investors In People, Business Excellence, ISO 9000) in their management and administration activities, but lack a structured approach to improving their actual emergency management systems.

1.1.3 Why assess using a Capability Maturity approach?

An answer to this question is suggested by Turner and Pidgeon (1997) citing Argyris and Schön,

"...if we are to reduce future emergencies we need to move beyond a simple cybernetic single-loop model of behaviour-feedback-change, to a state of so-called double-loop learning, where the very procedures for gathering and assessing signals about hazards, together with our theories in use for interpreting the world are directly challenged"

(Turner and Pidgeon 1997: 192)

This concept of double-loop learning is addressed by Capability Maturity models, and ensures that a system continually evolves with new knowledge. This makes it especially relevant to the emergency management application, as new knowledge and experience on safety and risk are continually arising on hazardous industry sites.

There are two additional reasons to select a CMM based approach. The first relates to the concept of maturity. Previous methods of assessment have focussed on performance, which was proven by carrying out an emergency exercise. An assessment of performance in one incident however, is not a reliable indicator of future capability to deal with a different incident, or even the same incident at some point in the future. A wider assessment of

capability is required to determine how well an organisation might manage incidents that could occur in the future. Such an assessment would be based on more structural factors, such as the emergency plan, staffing structure and evidence of learning, as well as demonstration of performance in an exercise. Maturity takes this one step further by giving an indication of how an organisation is likely to develop in the future, based on its current and previous levels of improvement. In an emergency management system, this type of output from an assessment could be very valuable to assure stakeholders of one's capability and commitment to improvement.

The second reason to select a CMM based approach is that CMM assessment focuses on the process rather than the product. This is especially relevant to EM, as the product of an emergency management system is not an easily understood concept. Previous methods of emergency management system assessment have been product-focussed, by assessing the emergency exercise. Unless the process that has produced that exercise is assessed however, there can be no indication of whether or not the same product will be produced again for any incident in the future.

1.2 *Aim and objectives of the thesis*

The aim of the thesis is to develop a risk-based, continuous improvement framework that can be used to assess capability and maturity in emergency management systems, primarily within major accident hazard industry. The model should have a people focus, and provide improvement guidance in addition to an assessment of current capability.

The objectives of the thesis are, first, to study the CMM concept to define how it can be changed to be more applicable to the emergency management application.

The second objective is to define the set of organisational processes that collectively produce an emergency response. These processes should incorporate all aspects of the emergency management system, and will be used in a CMM type framework to assess the capability and maturity of an organisation's emergency management system.

Objective three is to develop a protocol for using this assessment framework in an organisation. This will include defining how evidence of the processes can be found in organisations, and the opportunities and methods for assessing the processes.

The fourth objective is to test the model in an organisation. This should indicate the appropriateness of the assessment protocol, the completeness of the process set and the potential use and value of the results.

The final objective is to use the test data and any other available feedback to refine and improve the model, and to comment on its effectiveness and suitability as an industrial assessment tool.

1.3 *Researcher's learning objectives*

In addition to the academic objectives of the research presented above, the researcher also has a personal agenda to learn and develop as a result of designing and implementing this research study. The practical skills that will be developed include observation of people and systems leading to interpretation of the data and explanation of the outcomes in the context of the wider field and theory. The planning, implementation and management of a research programme involving several different industrial and governmental contributors is also expected to be a valuable and challenging learning experience.

As the interdisciplinary study of disaster and emergency management in the UK is becoming more established, it is hoped that this research will make a useful contribution to that field, and also encourage others from an interdisciplinary background to take part, and make a valuable contribution to research which has previously been the domain of specialist disciplines.

1.4 *Structure of the thesis and explanatory notes*

This thesis follows the classic learning-cycle structure, which involves defining a set of questions which need to be answered, then developing a model to answer those questions. This is followed by testing the model and using the test data to further refine and improve it.

CMM and PCMM are Registered Trademarks of SEI, Carnegie Mellon Institute. All data connected with this study has been kept confidential at the request of the organisations involved in the research.

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The second section reviews literature from the emergency planning and management field. It identifies the important issues in emergency planning policy, training and testing, followed by the maintenance and improvement of the plan and emergency response capability. The theme of capability improvement and assessment continues into Chapter 3, which describes models used for capability assessment and improvement in the organisational management field, and how they might be applied to emergency management.

2.1 What is risk

There are many different meanings of the term 'risk' in current use. Financial risk, business risk and health risk are well researched and will be briefly discussed where they relate to the main focus of the chapter, which is risk from major hazard industry.

A dictionary definition of risk is

"A dangerous element or factor; a hazard. Possibility of loss, injury, or damage. The chance of loss or the dangers to that which is insured in an insurance contract."

(Allen 2002: 784)

Renn (1998) believes that neither scientific understanding nor the public domain has a commonly accepted definition of risk. Renn recognises however that a common thread linking the majority of definitions is a distinction between reality and probability. He notes that risk can be associated with the possibility of an undesirable state of reality, or adverse affects, occurring due to human or natural actions, and defines risk as

"...the possibility that human actions or events lead to consequences that have an impact on what humans value"

(Renn 1998: 51)

This definition highlights the link between risk and uncertainty and that there is an aspect of risk which is outside human control. The consequences mentioned by Renn could be positive or negative. For clarity, this thesis will

2 Review of the literature

Literature relating to this subject is spread across many disciplines, from the social sciences to engineering, disaster management and organisational management fields, in addition to work conducted in the political and industrial arenas. This review will determine the important theories from the literature, and highlight the questions and issues that are raised. There are two main parts to the review and an additional description and review of capability assessment models presented in Chapter 3.

This chapter comprises two main sections. The first section reviews the subject of risk, bringing together the social scientists' view of risk with more theoretical work to describe what it is, how it is perceived and why it is important that risk forms the foundations of emergency planning and management.

The second section reviews literature from the emergency planning and management field. It identifies the important issues in emergency planning policy, training and testing, followed by the maintenance and improvement of the plan and emergency response capability. The theme of capability improvement and assessment continues into Chapter 3, which describes models used for capability assessment and improvement in the organisational management field, and how they might be applied to emergency management.

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refer to the negative outcomes of risk as costs and the positive outcomes as benefits. Renn's final notion is the concept of 'what humans value', suggesting that the impact of risk could have a subjective impact, in addition to the objective costs and benefits.

2.1.1 Probability

Renn uses the word 'possibility', which is only usually used in fuzzy logic terms to indicate a value between 0 and 1. Possibility is the non-quantified chance that an event could occur. The term probability is more commonly found in risk literature. Risk is defined in engineering as

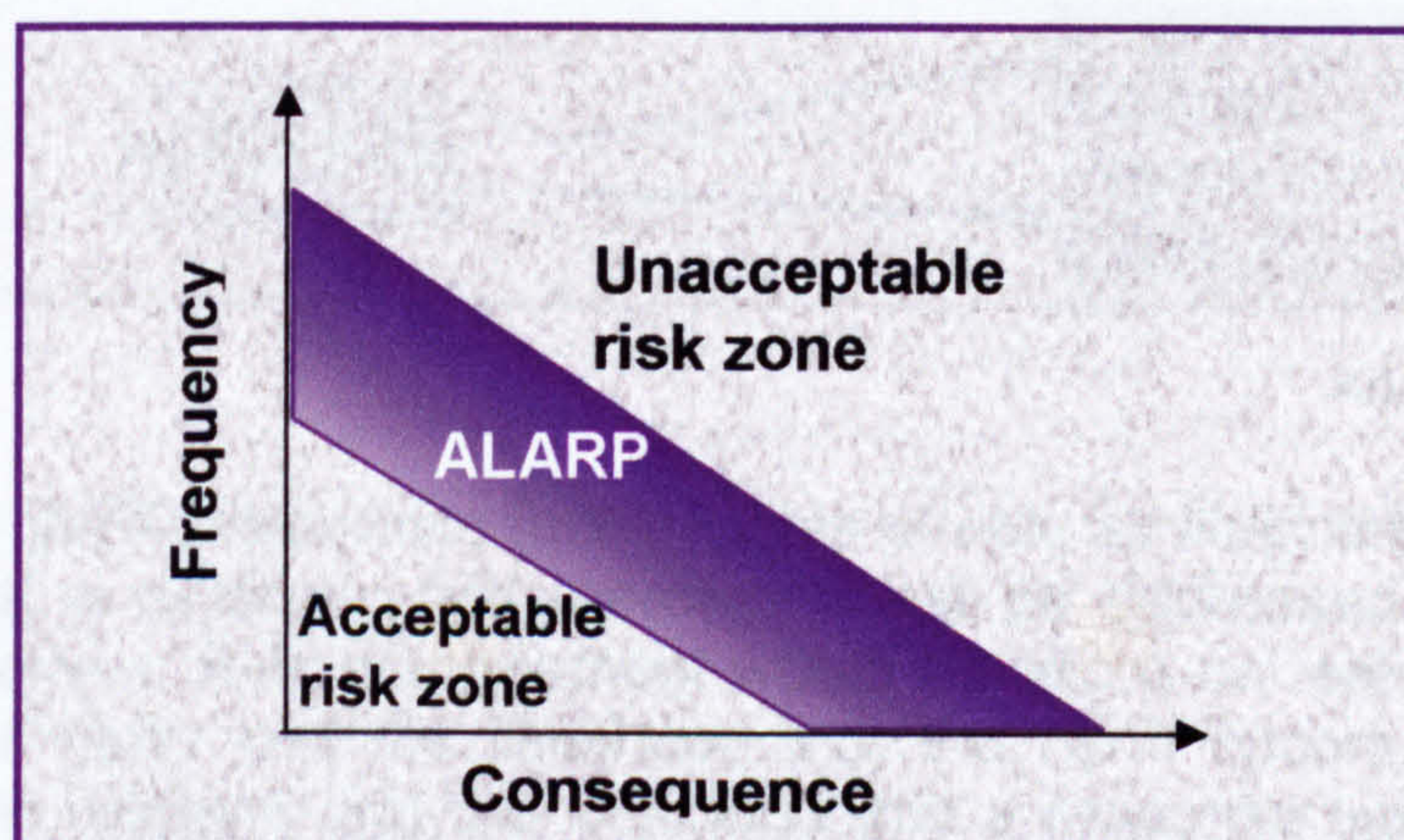
$$\text{Risk} = \text{Frequency} \times \text{Consequences}$$

or

$$\text{Risk} = \text{Probability} \times \text{Consequences}$$

Probability is a numerical measure of the chance of an event occurring, usually based on the frequency of previous occurrences of the same or similar event. Consequences in engineering risk are usually stated in terms of financial loss or human fatalities.

Figure 2-1 Definition of ALARP (As Low As Reasonably Practicable)



The diagram above shows that if an event occurs with low frequency and incurs low consequences, then the risk of that event is acceptable and measures to address are not required. Risk classified as ALARP (As Low As Reasonably Practicable) should be reduced as much as practicable, whereas risk identified as unacceptable by their high frequency or consequences must be addressed and reduced. The common definition of ALARP risk is where the risk to an individual falls between 10^{-3} and 10^{-5} or 10^{-6} , depending on the industry concerned (Strutt, 1999). Risk lower than 10^{-6} is acceptable, and higher than 10^{-3} is unacceptable.

It is usually the case that there is a distribution of uncertainty surrounding the frequency with which an event may occur, and uncertainty associated with the consequences of that event, so the risk is not precisely quantified.

Renn's allusion to human values is concurred by Cvetkovich and Earle (1992) who present a 'constructivist' definition;

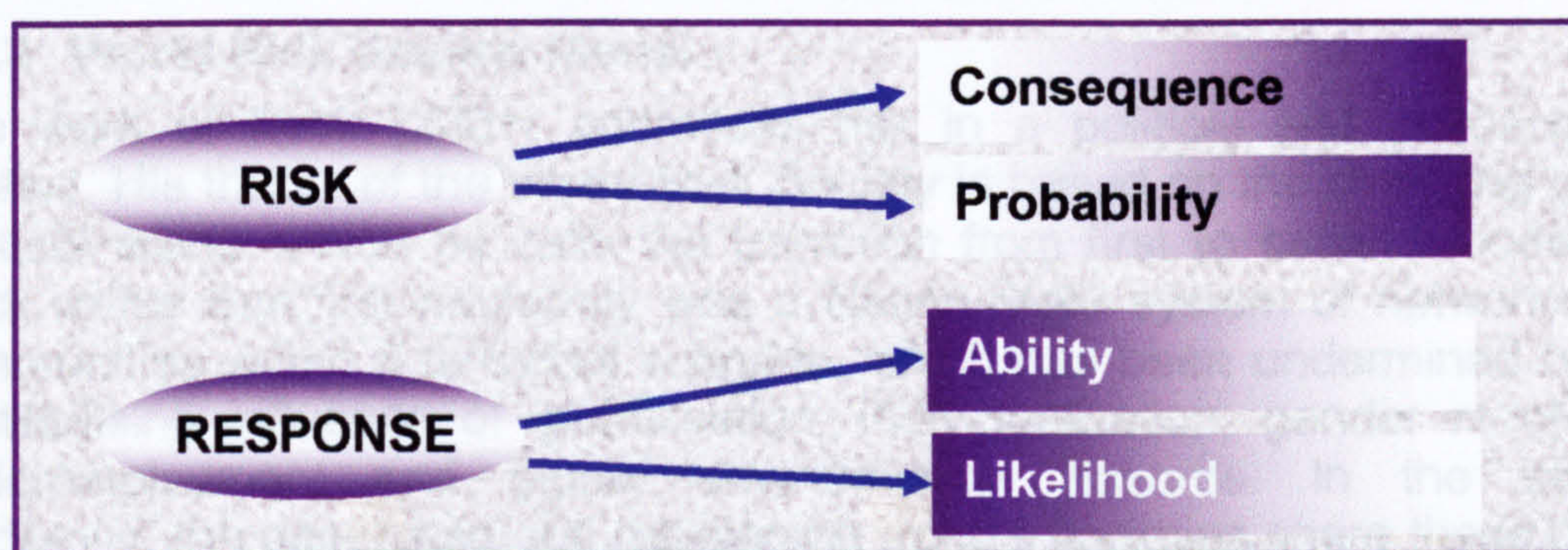
"...assessment of risk involves judgements about what is valued. Risk is not an inherent quality of the physical world, but represents an interaction between physical and psychosocial characteristics."

(Cvetkovich and Earle 1992: 6)

Cvetkovich and Earle also draw attention to the subjectivity of risk, mentioning judgement about what is valued. These authors present the useful concept of risk as an interaction between physical, engineered systems and the psychological and social characteristics of humans. This dual view of risk will be revisited throughout this review.

2.1.2 Daniell's model

Figure 2-2 Daniell's model of risk and capability



Adapted from Daniell (2000)

Daniell (2000) describes four aspects of risk, as illustrated above, and claims that risk is systemic and therefore must be addressed from all of the four perspectives. Risk management would therefore be tasked with reducing the scale of harm and the likelihood that the harm occurs, and increasing the ability to respond and the likelihood that a response would take place. With some similarity to Renn's argument, Daniell also mentions the idea of value, stating that the harm or negative side of risk is only half of the picture. The positive aspect of risk focuses on opportunity and also has four elements; the value of the opportunity and the likelihood that the opportunity will occur, and the capability to capture that opportunity and likelihood that the capability will be deployed. The concept of the capability of an organisation to respond to and benefit from risk is an important one to be carried forward through this study.

Pidgeon (1998) acknowledges two approaches to risk acceptability; firstly the psychometric group who use examinations and surveys to determine attitudes to risk, and secondly the socio-cultural camp who study societal groups and cultural factors for their understanding of risk. Beck (2001) extends the academic investigation of risk beyond just social science, asserting that

"The calculus of risks connects the physical, the engineering and the social sciences".
(Beck 2001: 51)

He further acknowledges that the technical fields also have a role to play in the risk arena, stating that

"Risk statements are by nature statements that can be deciphered only in an interdisciplinary (competitive) relationship, because they assume in equal measure insight into technical knowledge and familiarity with cultural perceptions and norms".

(Beck 2001: 138)

The president of the US National Academy of Sciences, cited in Douglas and Wildavsky (1983), agrees that the estimation of risk is a legitimate activity of scientists in governments, universities and research bodies, as it is a scientific question. The acceptability of risk however is a political question and should be determined in the political arena. It would seem from the authors cited above that risk acceptability is not only political, but also a social and cultural concern. The cultural and social aspects of risk acceptability are discussed by several authors, reviewed later in this section.

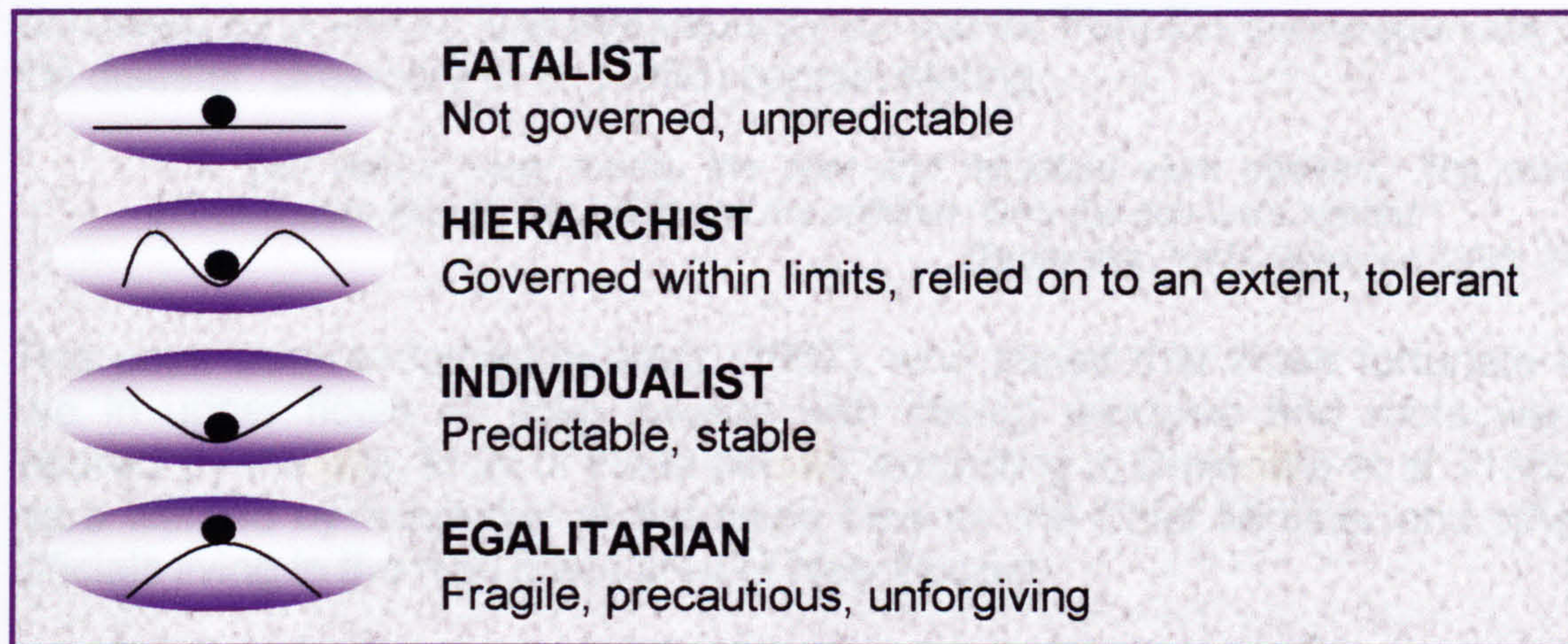
2.1.3 World Risk Society Model

The work of Beck (2001) addresses risk in a political and philosophical context. His theory of the World Risk Society is based on the changing global political arena, which he calls the transition from first to second modernity. Beck writes that first modernity was a Nation-State system of networks and communities within a territorial scenario, which has been undermined by the destabilising influence of globalisation, individualisation, gender revolution, underemployment and global environmental hazards. In the second modernity, the developed and developing world's societies share these global challenges in different environments and through differing cultural and political perceptions. Beck's work is macro-political in its focus, and it provides insight into the international backdrop against which this study is conducted.

2.1.4 Risk Culture Theory

The relationship between risk acceptance and culture is explored by Douglas and Wildavsky (1983: 186) who allude to three main types of personal outlook, or culture on which people base their risk selection. Adams (2000: 37) also discusses the risk cultural theory, suggesting that it provides a means of organising responses to uncertainty. He states that the different categories identified within the theory hold unique views on how risk might be better managed. Adams illustrates this by transposing human nature onto physical nature, dividing the human race by their attitude to risk, into four (as opposed to Douglas and Wildavsky's three) groups. The black balls on the diagram below represent the human and the line represents their boundaries. This approach to cultural outlook on risk is useful, as it gives risk and emergency planning professionals some concept of the potential reaction to and implications of their decisions.

Figure 2-3 Adams' Risk cultural groups



Adapted from (Adams 2000: 37)

The ways in which different groups and individuals response to risk are widely discussed, with different perspectives being provided by Cvetkovich and Earle (1992), Sjöberg (1996) and Tierney (1999). An important point to take forward is that different people react to risk in different ways, and individuals may react differently at different times, to the same risk.

2.1.5 Risk based decision making

The authors cited in the previous section differ in their opinions of whether risk decisions should be based on statistics and probabilities of a hazardous event, or on human perceptions and opinions regarding danger and potential loss. There have been attempts to simplify risk decision making by grouping a population's aversion to risk based on sex, nationality, social status and other factors. These will be discussed later in this section. An interesting discord between the work of Tierney (1999) and of Beck (2001) is that Beck does not consider natural hazards as part of his World Risk Society model, as he deems there to be little decision making involved. Tierney regards natural hazards in the wider sense of human vulnerability, which is decision based, and hence should be considered similarly to anthropogenic hazards.

2.1.6 Vulnerability and risk

Vulnerability, or the state of being open or susceptible to damage or attack, is created by decisions. In their examination of natural hazards, Blaikie et al. give a working definition of vulnerability as

"...the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard."

(Blaikie, Cannon, Davis & Wisner 1994: 9)

This definition clarifies how vulnerability affects people. These effects are the same irrespective of whether the hazard is natural or technologically based. Vulnerability is well illustrated by the Bhopal disaster of 1984 (Shrivastava 1992, Weir 1987). Inhabitants of the squatter settlements surrounding the plant were vulnerable in the sense of their close proximity to the plant and well ventilated shelters into which the toxic gas could easily pass. They were made more vulnerable by their lack of detailed knowledge of the hazard or any

coping strategies they could use. Finally their vulnerability was further increased by a lack of financial capacity to recover from the consequences of the disaster. Brojendra et al. (1986) concur, stating

"The gas victims were mostly the poor and famished slum dwellers. The worst affected were the old, the infirm and the children. Only the rich were spared."

(Brojendra, Nath, Banerjee 1986: 21)

This point was reinforced by Weir (1987), who stated that those fortunate to live in upper floors of solid houses with sealed windows and roofs were 'spared' by the gas. Most of these people, according to Brojendra et al. (1986) were warned by telephone at the same time as the Chief Minister and other officials living in the high-class area of New Bhopal.

As shown above, the vulnerable are more likely to bear the cost of risk than the people who enjoy the benefit. The following section briefly discusses how cost and benefit of risk are analysed to make a judgment on risk acceptability.

2.2 The costs and benefits of risk-taking

One factor which motivates people and organisations to take risks is the potential benefit or reward. Benefits are usually measured in terms of financial reward or savings. They are specific in time and magnitude and directed to particular recipients. It is difficult to find a common unit of measurement for both cost and benefit, and so comparison of the cost of risk versus the benefit is rarely simple, however this analysis is a crucial part of risk-based decision making. Reaching a decision about the acceptable level of risk involves different groups of people with differing agendas who are motivated by a range of factors. The final subsection will investigate how risk decisions are made, and the variables which form part of that decision making. It will examine the theory of risk from three perspectives. The first perspective is cost, which is the negative aspect of risk.

2.2.1 Types of cost

Beck (2001) suggests that even without the risk being realised or an event occurring, there is a cost in terms of the loss of trust and security. He defines risk as

"...no longer trust or security, not yet destruction or disaster."

(Beck 2001: 135)

These costs are not easily measured or quantifiable, but on a personal and social level they are recognised as negative effects. This psychological cost, commonly known as 'living in fear', is often underestimated. After the Chernobyl accident in Ukraine, other nuclear reactors on that site continued operating for 14 years. To date, 45,000 people in that region have received psychological care and over 3 million are estimated to suffer from Post Traumatic Stress Disorder (PTSD), related to the insecurity and fear they experience, living close to the site of an incident which has been responsible for the deaths of over 7000 people over the past 16 years (UNDP 2002).

The second level of cost is the potential range of physical effects that an incident could inflict on the community if the risk was ever realised. Lind (2002a: 21) states that a characteristic of public risk is that the loser is unknown in advance of a loss.

2.2.2 Gender related vulnerability

Inequality in the distribution of risk throughout society is further discussed by Tierney (1999: 70), who identifies women as being disproportionately affected by the cost of risk. The release of MIC gas in the Bhopal chemical disaster effected a disproportionate burden on the female victims. Exposure to MIC resulted in reduced fertility, an increase in gynaecological difficulties and still-born or deformed children, in addition to a poor state of general health and an inability to work. These factors have added immeasurable pressure to the already difficult life of a lower-caste woman in India (Basu 1994). Further work into the subject of gender division in risk has been carried out by Sjöberg (1999) and Anderson and Manuel (1994) among others.

2.2.3 Global system risk

There are now a number of hazards which have no geographical boundaries. The interconnected nature of the food chain, global wind and air circulation and the water cycle mean that it is not possible to contain or isolate some pollutants.

Beck (2001: 77) asserts nuclear and genetic hazards cannot be constrained in time, or place and therefore exceed our capacity to cope with them. The effects cannot be compensated for and the perpetrators are not accountable to the rules of liability, causality or blame. The Chernobyl incident caused the severe radioactive contamination of an area spanning 160,000 sq km of Ukraine and Belarus. The medical professionals in the region expect to diagnose 8000 cases of cancer over the coming years (UNDP 2002).

"...the injured of Chernobyl are today, 16 years after the catastrophe not even all born yet"

(Beck 2001: 77) (Emphasis as in source.)

The cost of over 17,000 cases of cancer and 200,000 people living in conditions of severe radioactive contamination is immeasurable. Grazing for livestock in some areas of the UK has just been declared safe following radioactive contamination. Sjöberg (1996) also states the cost in terms of the public perception of nuclear energy as irreparable. Although considered to be improbable events, high-impact major industrial catastrophes are often the catalysts for change in the emergency and disaster field. They reinforce the need for other industry to assure its stakeholders that the necessary safeguards and plans are in place to prevent such consequences occurring again.

2.2.4 Measurement of cost

"The only person who knows the value of loss is the one suffering it."

(Adams 2000: 23)

This clear statement from Adams enforces the argument that those who are responsible for risk decision-making are rarely aware of the full potential cost of that risk. Adams uses the term 'value' rather than cost in this quote, a concept discussed by Pidgeon (1998), who distinguishes between the values individuals hold, for instance the protection of animals, and things we place a value on, such as fresh air, clean water and public transport. Pidgeon questions whether one can place a value, monetary or preferential, on things in life which we value. Insurance companies place a monetary value on our sight, hearing, limbs and mobility but the value of our freedom of movement and expression are much more difficult to quantify in monetary terms.

Tierney (1999) makes a clear distinction between value and cost using the example of two buildings, each worth \$1.2 million. One building is the country residence of two wealthy bankers. The other building is an inner-city apartment block housing ten low-income families. Quantitative Risk Assessment (QRA) would 'value' both buildings at \$1.2 million, giving them equal standing. What is not recognised by QRA is that the bankers are heavily insured against damage to their building, and could easily replace it. The ten low-income families have no insurance, and would be unable to replace their homes. The value of the building is therefore far greater for the ten families, than it is for the two bankers.

Terminology can be a problem in the study of risk. Cost and value are used interchangeably; however they can mean different things. Cost is defined by the dictionary (Allen 2002: 190) as "the price paid or charged for something", and value has definitions relating to monetary worth, as well as usefulness and importance. The distinction between cost and value is important in emergency planning, as items which might not be very costly in financial or QRA terms may have a high value in emotional and sentimental terms, to the owners. This human aspect of emergency planning is addressed more thoroughly later in this chapter.

2.2.5 Value of life

A second area where the terms 'value' and 'cost' are confused is in so-called 'Value of Life' (VOL) calculations. Ives, Kemp and Thieme (1993) recognise the controversial nature of their work in this area and are careful to stress the pitfalls. They describe earlier work, such as the concept of Human Capital, favoured in the 1970s. It attributed direct costs to grief, pain and other morally inestimable factors. A contemporary technique is called 'Willingness to Pay' (WTP), which measures the monetary figure people would be willing to pay for and increase in safety or for example the retention of an historic artefact. WTP and its counter-measure 'Willingness to Accept' (WTA) will be discussed later in this section.

Many ethical questions arise when discussing the value of life. Are all lives equal? Is the value of a future life equal to the value of a current life? With so many difficult questions, it is clear that VOL can only be used to aid risk-based decisions, and must be carefully placed in context. Lind (2002b: 27) agrees that VOL is an ethically difficult subject to approach, and suggests that it is

preferable to compare projects on the basis of number of lives lost or saved relative to the cost.

In 1992 Marin (cited in Adams 2000: 23) gives an equation for the cost per head of population of a change in risk to life. The equation is convenient and simple, but it assumes that risk is evenly distributed over the whole population, which is rarely the case. The second assumption is that the VOL is equal across the population. This is ideologically correct, but invites arguments on the relative VOL across society.

In risk assessment it is important to recognise that not all of the consequences of an incident can be generalised across the affected population or classified in terms of monetary worth. The psychosocial consequences of disaster are equally important considerations when writing an emergency plan and carrying out preparedness measures. In this context, guidance on meeting the social and psychological needs of disaster victims has been provided in 'Disasters: Planning for a caring response' (Disasters Working Party 1992), discussed later in this review. Beyond the scope of this thesis, Gerrity and Flynn (1997) provide a thorough analysis of the mental health consequences of disaster, which examines the range of human responses to stress and disaster along with interventions that can benefit the victims.

2.2.6 The benefits of risk

In addition to the potential and real costs or loss arising from risk taking, there are also potential benefits. In extreme sports the individual benefit is sensuous. Pleasure is created by adrenalin and endorphins released into the blood stream. In business, the benefits from risk-taking can be increased productivity and profit.

In Daniell's model (Daniell 2000) discussed in section 2.1.2, the four aspects of risk are mirrored by the four facets of opportunity he associates with risk. He alludes to the value of the opportunity, the likelihood of that opportunity arising, the capability to take advantage of that opportunity and the likelihood of deploying that capability. In order to take full advantage of the opportunity, all four angles must be addressed. While Daniell portrays this model as being equal and balanced in terms of risk and opportunity, organisational reality seems to differ. Organisational attitudes to negative risk are often 'it could never happen to us', but their attitude to profiting from the same risk is proactively managed to ensure that it does happen to them, and they make as much from it as possible.

This is a view supported by Douglas and Wildavsky (1983: 88) who state that an organisation's latent goals are more influential than the goals which an organisation makes known to the public. An example of this is the oil industry, which vehemently publicises its goal of environmental protection. Their true organisational objective is to make money from selling the oil to customers who will burn it. Their benefit is the profit from oil sales, which supports the argument that Daniell's model should actually be lop-sided, with far greater emphasis being placed on ensuring that opportunity is exploited than effort

placed into preventing negative consequences. Focussing on the improvement of emergency management, it is important to recognise the constraints of working within an organisation whose principal goal is to generate profit.

2.2.7 Measuring and comparing benefit

Comparing the consequences to the benefits of a particular risk in a balanced and equitable manner is difficult. Benefits and costs may not occur at the same time, in the same location or to the same population. Their units of measurement might mean comparing quantitative benefits to qualitative losses or vice-versa. This is illustrated using the example of a chemical plant on the banks of a fast-flowing salmon river. Upstream, the community benefit from the employment and revenue the plant provides, which is quantifiable. Downstream, the community suffer from the water pollution and environmental degradation, which is less quantifiable. In many cases however, the true cost of risk is deliberately hidden behind complex equations and lengthy time-spans, because equitably exposing the true costs of many risks would render them unacceptable.

2.3 Perceptions of acceptable risk

With so many factors influencing the comparability of risk costs and benefits it is difficult to see how individuals and organisations decide an acceptable level of risk. This part of the review will discuss some of the models and frameworks used to justify risk-related behaviour, and what influences risk-based decision making. The issue is summarised succinctly by Renn who states

"People are willing to suffer harm if they feel it is justified or if it serves other goals. At the same time they may reject even the slightest chance of being hurt if they feel risk is imposed on them or violates their other attitudes and values."

(Renn 1998: 58)

2.3.1 Psychometric approach

Given minimal information about a risk, there are several factors which can help form the basis of an opinion. These factors were distilled in Starr's work of the late 1960's, developed further as the 'psychometric approach' to risk perception by Slovic and Fischhoff in the late 1970s, and described in Sjöberg (1996). The approach is based upon nine risk dimensions;

Figure 2-4 Psychometric approach, risk dimensions

Voluntary	→	involuntary
Delayed effect	→	immediate effect
Known precisely to exposed person	→	unknown
Known precisely to science	→	unknown
Controllable	→	uncontrollable
New	→	old
Chronic	→	catastrophic
Common	→	dread
Certain not to be fatal	→	certain fatality

Sjöberg (1996: 220)

Whilst these factors remain a useful distillation of how risk might be perceived, the work was criticised because the dimensions were not proven conclusively through experiment, and the sample of people Starr chose was selected for convenience and was not representative of the population.

2.3.2 Inequality in risk decisions

The dimensions illustrate that there can be lesser and greater risks, evaluated by many different factors. Risk-based decision-making can begin only when such an evaluation has been made. The decision-making is rarely in the hands of those who may suffer the costs of the risk, however. As stated by Adams;

"The people with greatest responsibility for decisions about societal risks of a physical nature are usually the best insulated from those risks."

(Adams 2000: 190)

This is proven in the Bhopal example, where the technology and design of the Bhopal plant were imported to India from the United States. Pearce & Tombs (1998), Khare (1989) and Meshkati (1991) describe how the high-hazard Union Carbide plant was built in India despite widespread lack of faith in India's ability to operate the plant safely. UCC along with the Government of India (GoI), decided that the risk was acceptable, as they were physically isolated from that risk, and focussed on the gains rather than the potential losses.

The same theory is played out in the political arena, where International Financial Institutions (IFIs) instigated a policy known as the Green Revolution to increase India's debt repayments by encouraging focus on chemically and mechanically intensive farming. The IFIs' decision to implement the Green Revolution was also taken by people who would never suffer the consequences if the project failed. Without the Green Revolution induced demand for pesticides, the Bhopal plant would not have been built.

The above examples show that different groups can find the same risk acceptable to a greater or lesser extent. Just as different cultures have varying risk perceptions, there are also divisions within cultures. The review to this point suggests that there are three main views of risk, held by different groups. These groups are the public, which includes pressure groups, individuals and local representative bodies; the political group which is made up of political parties, intra-governmental bodies and supra-national organisations such as the United Nations (UN); and the professional group, which comprises of industrial experts, risk managers and academics that have specialist knowledge in the field of risk. These three groups form a useful framework upon which to base the review of risk acceptance and risk-based decision making.

2.3.3 Public acceptance of risk

The public's attitude to risk is based around shared experience, according to Douglas (1986). They use joint knowledge to determine which of the

foreseeable losses are most likely to occur, which of those probable losses would be most harmful and which aspects of the harm might be preventable. The public also construct a scale of values ranging from serious to trivial, against which different consequences are evaluated, a concept which is in agreement with the Psychometric approach, risk dimensions shown in Figure 2-4 and based on the original work by Starr. Douglas suggests that public rejection of a risky concept may not necessarily be due to ignorance, but instead may be a reaction of anger and objection to involuntary risk and the system which imposes it. Douglas (1986) voices the rather radical view that rather than committing resources to reducing risk, the way forward is to increase public tolerance to higher levels of societal risk-taking. Pidgeon (1998), however warns against organisations focussing on reducing the perception of the risk rather than reducing the actual risk.

Douglas's approach is based in social science, and is a useful concept for emergency planners and risk managers. The views of the public, rather than traditionally disregarded as irrelevant and uninformed, should be encouraged in a structured format. This can provide the organisations with boundaries of acceptability within which they must operate. Eliciting these boundaries and the requirements of different stakeholder groups is a key part an organisation's emergency and risk management responsibility, and will be discussed later in this research.

2.3.4 Right to participate

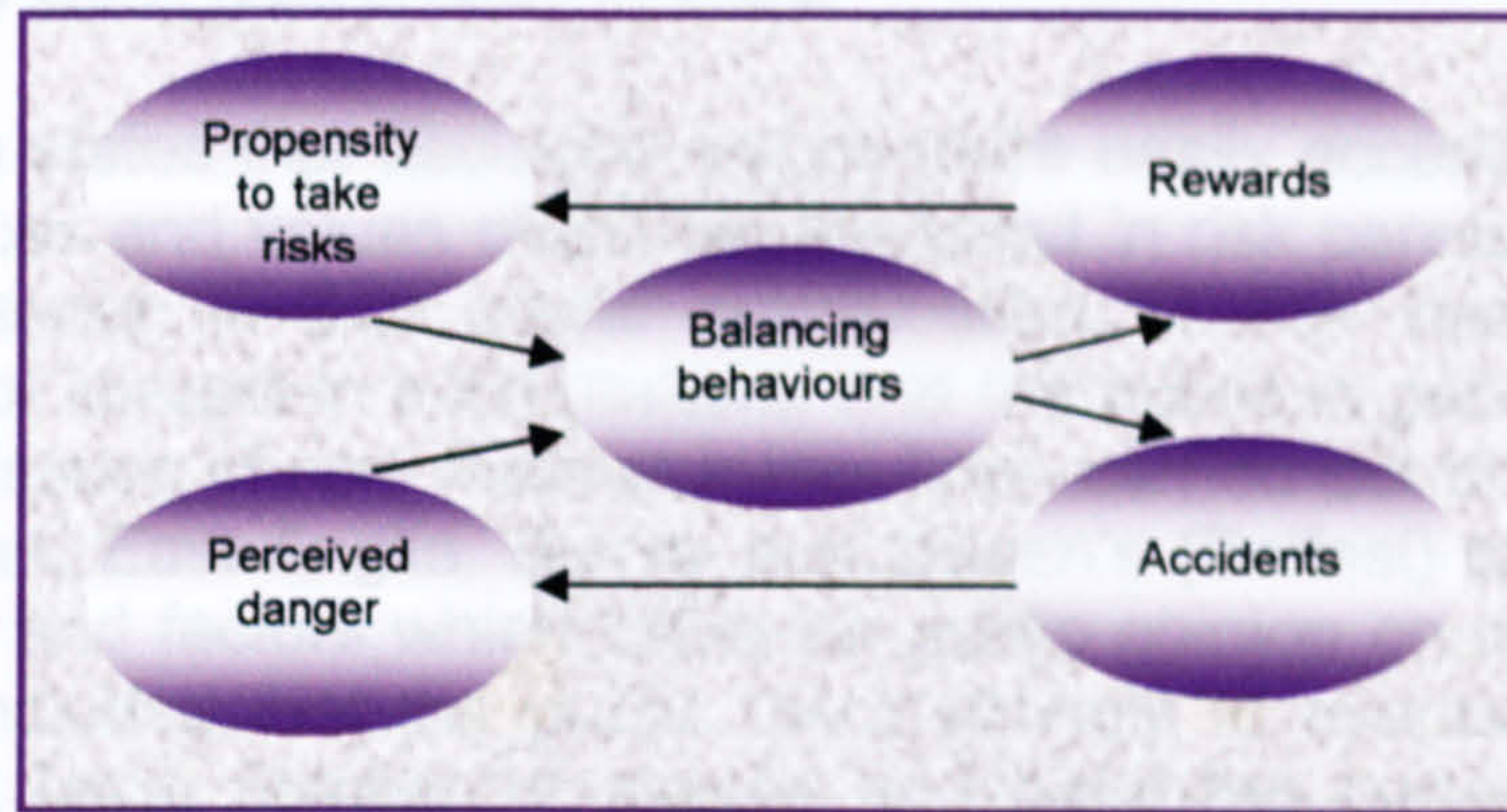
Public inclusion in risk decision making has long been a contentious issue. Beck (2001: 43) cites the work of Frankfeld who details the goals of citizenship as dignity, autonomy and assimilation of members of the polity. Citizenship therefore includes participation and the joint right to knowledge and information. It also includes the right to informed consent and limitation of endangerment of collectives and individuals. One could define this as 'risk citizenship'.

Cvetkovich and Earle (1992) illustrate the concept of risk citizenship, referring to the Superfund Amendments and Reauthorisation Act (SARA) Title 3, in the United States. The Act established Local Emergency Planning Committees (LEPCs) which were given the mandate of planning community response to chemical incidents. Some of the committees have now become effective discussion forums for a wide range of hazards. The United States Environmental Protection Agency (EPA) is considering the LEPC approach for utilising community participation in other environmental issues.

2.3.5 Risk thermostat model

Adams (2000) has developed the 'risk thermostat' model graphically to illustrate the behaviour of individuals making risk-based decisions.

Figure 2-5 Basic risk thermostat



Adapted from (Adams 2000: 15)

The basic risk thermostat (Figure 2-5) illustrates the influences on an individual's attitude towards risk. Rewards for risk-taking affect the person's propensity to take risks, and accidents shape the person's perception of danger. These factors then shape the behaviour of the individual to balance the rewards against the accident risk, and modify his or her actions. The nodes can be shifted to indicate bias within an individual. Balancing behaviour can either be influenced by objective rewards and accidents, or subjective risks and danger. The thermostats can also interact in systems where the behaviour (risk-taking or perceptive of danger) can influence the behaviour of other parts. Examples of this include the behaviour of busses influencing the behaviour of cyclists, or the commercial behaviour of suppliers influencing the behaviour of manufacturers.

Acceptance of risk is strongly linked to what people value, according to Sjöberg and Torell (1993). These authors also clarify that this evaluation is not solely based on moral values, but also economic and cultural values, which highlights an important point for emergency planning and management. Stakeholders in an emergency management response can include the local population, an organisation's personnel, the wider public, political groups as well as suppliers and clients. Each stakeholder has his or her own framework for evaluating what is acceptable in terms of the risk to health, job, beliefs, security and assets. Emergency planners and managers should be aware of their stakeholders' requirements if the emergency management system is to be acceptable.

2.3.6 The use of public risk perception

Given the variability of public opinion and perception of risk, caution must be exercised in recommending its use and value in risk management and regulatory decision making. Pidgeon (1998) provides a comprehensive argument on the topic, giving five reasons for and against using risk perception in this way.

In favour of using risk perception, Pidgeon states that technocracy should always come second to democracy. The public should always have a say in something which will affect them. Participation in design also gives a greater sense of ownership to the public, and increases their commitment to and faith

in a particular course of action. This is in agreement with the comments on citizenship by Beck (2001) cited in 2.3.4.

Pidgeon also states that decisions will be more easily accepted if they reflect the preferences and values of the people found in risk perception. The fourth reason in favour is that social amplification of risk has resulted in a heightening of interest in such matters, and the public in general have strong opinions on issues of risk. Research has been carried out at the Universities of Birmingham, East Anglia, Surrey and Queen's (Belfast) to investigate the mechanisms and factors which influence public opinion on risk matters. The research concluded that the public react strongly to events which have an impact on a large number of people and have the capacity to generate outrage and an emotional response (Department of Health, 2001).

Pidgeon finally alludes to the value of Special Interest Groups (SIGs), made up of lay people who have carried out extensive research into the particular risks involved. In comparison to experts who are likely to conceal bias, lay people are more inclined to declare their partiality and personal opinions. Public perceptions and the contribution of SIGs are likely to enrich the expert approach, which is inclined to focus on quantitative costs and number of fatalities rather than distribution of risks and societal effects.

Pidgeon (1998) also gives five reasons against using public risk perception in regulatory decision making. He notes that the public are not sufficiently knowledgeable to accurately evaluate what may harm them. Their views are not grounded in science, and could result in the misdirection of resources, a view concurred with by Fiorino.

"Given the sheer complexity of the issues, the trans-scientific nature of the factual premises and the rapid changes in definition of the problems and their solutions, the lay public lack the time, information and inclination to take part in technically based problem solving."

(Fiorino 1990: 227)

Fiorino later states that he would welcome a mechanism to explore and integrate public perception of risk.

Pidgeon's second reason is in the interests of equality, and Pidgeon notes that public risk perceptions may sometimes be biased against certain groups. This could steer public policy into damaging and discriminating actions. One example is the areas of the world where HIV is blamed on the sufferer, and there is a stigma attached to the virus and those who are infected with it.

Thirdly, as mentioned in 2.3.3, if public perception played the major role in decision making, then the organisations causing the risk would simply have to manage the perceptions through public relations and image management, rather than manage the risk itself. Ultimately this would be a regressive step for the field of risk management.

The penultimate reason given is related to the heterogeneity of the public. Individuals and groups select different risks on which to focus their concern,

and represent them in different ways. With such a range of views, it would be difficult to satisfy a majority, and reach an acceptable representative decision.

Finally, Pidgeon states that public perception is socially constructed from numerous influences and interactions in the cultural and social arena. Justifying and accounting for perceptions and therefore the nature of the aversion to or acceptance of risk would be difficult. Each risk decision would have to be dealt with individually, as it could not be assumed that previous decisions could be replicated to a different location or point in time, as is common practice with technical risk assessments.

2.3.7 Professional decisions on risk acceptability

The title of professional in the field of risk can include scientists, engineers, organisations, academics and consultants. Their opinions and evaluation of risk are traditionally given higher credibility than public opinion. It is only with the growing interest in risk from the social sciences that the authority of some of these professionals is being questioned.

Douglas and Wildavsky (1983) recognise the limitations of the scientists involved in the risk profession. However professional their attitude, their opinions will have been unconsciously polarised towards either risk taking or risk aversion through their life experience and personality. Conversely however, Douglas and Wildavsky go on to state (1983: 73) that the engineering expert's risk assessment is often de-contextualised and dissocialised.

Rather than the experts being at fault, it seems they are placed in an almost impossible position. They are berated for allowing their personal experience to affect their judgment of risk acceptability, and berated for ensuring that their judgement in risk assessment is not affected by context and social condition. A good deal of the conflict in this field can be attributed to misunderstanding and distrust between the social science field and the engineering mathematicians. One solution is to adopt an attitude of accountability in all risk and emergency matters. The mechanisms for achieving this in an emergency plan and management system will be discussed later in this study.

2.3.8 Engineering risk acceptability

A number of methods are used to represent acceptable risk criteria, including the use of $f.N_{max}$ plots. These graphs show incidents plotted according to their frequency on the Y axis against number of deaths (or quantity of loss) on the X axis. Acceptability can then be indicated on the graph, showing which incidents were acceptable, and the likely acceptability of any future incidents of a certain magnitude. An example of this can be found in the work of Hirst and Carter (2002) who have devised a method for measuring societal risk from a hazardous installation. The use of $f.N_{max}$ plots attract controversy in the literature, as certain social scientists see this effective means of displaying data as an example of engineers attempting to impose acceptable risk criteria. This view is voiced by Lind (2002b: 27).

Hoegberg (1998) describes an alternative to $f.N_{max}$ plots. The Swedish nuclear regulator uses risk profiles rather than a single worst case numerical risk estimate favoured by Hirst and Carter (2002). Risk profiles include quantitative and qualitative descriptions of scenarios, which are made up of events, sequences and processes. These scenarios also have detrimental consequences and estimated probabilities. Risk profiles can be compared to social activities and natural examples, and the value judgments compared where appropriate.

Both methods have benefits and disadvantages, and should be used as specific circumstances dictate. The important point to draw from this is that the acceptability of risk is a complex issue, and it is not easy to summarise it with a single model, equation or theory.

2.3.9 Political risk decisions

In many cases the final decision regarding the acceptance of a risk lies with a political body. These range from specially commissioned enquiry groups to government departments and regulators such as the Health and Safety Executive (HSE) and Environment Agency (EA). Responsibility and accountability in political organs are sometimes difficult to guarantee.

This is illustrated by Douglas (1986: 63), who cites the Kemeny report into the Three Mile Island (TMI) accident. The National Radiological Commission (NRC) was responsible for safety of operations at the plant, but did not have a remit or staff to investigate or monitor Man-Machine Interface (MMI) issues. The control room at TMI during the accident had three audible alarms sounding, many of the 1600 warning lights activated and the warning computer was running far behind the sequence of events. Over 40 people were present in the control room, and telephones were ringing constantly (Perrow 1999: 28). The NRC was democratically constructed by society, and its remit was dictated by the wider populace, who are unlikely to have a wide appreciation of operations systems in nuclear power generation.

2.3.10 Influences on decision making

The previous section determined that the public, professionals and politicians are responsible for deciding the level of acceptable risk to be faced by society. Their decisions are influenced by many factors, the more salient of which are discussed in this subsection.

2.3.11 Media influence

The media are one of the major influences on risk decision making. Sjöberg (1999) emphasises the influence of the media on risk perception, and the often oversimplified picture of risk that they represent. Tierney (1999) agrees, stating that the media generally favour monocausal explanations, especially focussing on the actions of a single actor in order to attribute blame. Sjöberg does not however, distinguish between different media organs, which operate to different agendas in different countries. The media has a much more varied influence than is often recognised.

The information output of the media is also used and interpreted by the public in a range of ways. Trumbo (1998) suggests from his experimental work that relationships exist between the type of communications channel used, and its cost and utility. Cost in this sense is the amount of effort needed to access the information.

Douglas (1986) argues that the public tend to focus on media enhanced risk, such as nuclear power, HIV and cancer, and to underestimate familiar, situational risk such as asthma. She discusses the concept of salience, which means making one interpretation more available or visible than another. Salience could help explain the difference in perceptions of risk between cultures and at different points of time, as the media gives salience to large scale disasters for a time after the impact, but coverage fades once the drama ends.

Public concern about technical risks and heightened media reporting may also intensify the responsiveness of the official decision makers, keen to be seen by the public to be contributing and taking positive action. Cohen (1998), a staunch supporter of 'hard science' over perception and public concern, states that the media is directly responsible for the public perception of nuclear power being totally out of touch with the results of scientific risk analysis. Whilst it is clear that the media in general have not supported the nuclear industry in the UK or USA, the public distrust of nuclear concepts is more likely to stem from a lack of understanding of radiation. As illustrated in Starr's work in 2.3.1 a factor which is dreaded is likely to be perceived as highly negative. Radiation, an energy that the public cannot see, hear or taste and yet can cause incurable disease and death, is certainly dreaded.

The media are an important tool and should feature in any emergency management system. If managed well, the media can be an asset to the emergency response. If neglected or managed badly they can compound the negative consequences of any incident. In a multi-agency emergency response, the media may be one of the agencies and so a means to formally acknowledge this and develop the relationship with the media in emergency planning is regarded as an important issue for the research.

2.3.12 Social and Cultural influence on risk decision making

Cultural factors have been shown to influence risk decision making. This is discussed by Douglas (1986: 67). Culture is defined as a publicly shared collection of values and principles used at a particular time to justify behaviour. An individual's decisions and views are moderated and homogenised by the groups which they are part of. Acting as a group, Douglas (1986) suggests that they essentially carry out cost-benefit analyses of the decisions, and decide on the most beneficial course of action to maintain their group interests. Douglas also suggests that groups of people are likely to make riskier decisions than individuals. Research in the 1970s labelled this as the risky shift phenomenon, and it is known in contemporary work as group polarisation of attitudes or group choice shift.

One of the pertinent problems of judging and assessing the value of cultural inputs into the risk field is that every human is part of, or affected by culture in some way.

"There is no impartial referee available to judge the appropriateness of cultural constructions."

(Renn 1998: 59)

Renn (1998) argues that the selection of risk issues for concern and motivation for action is based on cultural conventions and social constructions.

The Royal Society (1992) cites the key work of Starr in 1969 which used the method of revealed preferences. This investigates the implicit trade-offs made in a society, balancing the risks and the benefit of a hazard by analysing currently accepted levels of accidents. Four of Starr's key points are cited by Douglas (1986) and looked upon as defining points in the risk field. Starr concluded that victims and benefactors of risk will have differing views. This point is echoed by Beck (2001: 10). People also have expectancies of control over the risk they are exposed to. Voluntary and involuntary risk attracts different reactions from the public and perception is affected by the magnitude and visibility of the type of risk.

2.3.13 Risk Compensation theory

Considering an individual's acceptance of risk, Douglas (1986) questions a link between the level of risk experienced in that person's occupation and the level of risk they expose themselves to in their social life. Douglas offers no answer to this, whereas Adams (2000) proposes the Risk Compensation theory, which suggests that if the environmental circumstances change to reduce the risk we are exposed to, we will adjust our behaviour to restore their original level.

Adams (2000: 60) supports his theory by citing the trend in number of deaths by accident and violence on a global scale between 1900 and 1980. Overall, the trend for the 31 countries studied remains constant over the 80 year period, with no major fall or rise in the death rate. Major wars and disasters show small blips in the trend, but it returns to a similar level, despite advances in risk reduction and technological advancement. Adams argues that this is because as we gain control over a particular risk, another risk emerges.

2.4 Risk literature conclusions

In order to use aspects of risk-based emergency planning later in this study, it was necessary to develop a clear understanding of risk. This section of the literature review introduced risk from several different perspectives, looking in detail at the cost, the benefit and achieving an acceptable balance.

Global-level risk, including environmental, transport, energy and terrorism, has no boundaries and has the potential to affect millions of people. These people will perceive and react to risk in different ways, influenced by different factors, depending on their culture, social group and background.

Risk is different according to population and location, and it also varies in time. The concept of risk includes people and a hazard in an environmental context. None of those variables is constant, and so risk is continually changing. A risk evaluated ten years ago will not be the same today, and a risk acceptable today might not be acceptable in ten months' time. The dynamic nature of risk demands a dynamic and adaptive approach to emergency management and planning in MAHIs, and this will be a large focus of the following chapters.

2.5 UK Emergency planning and management

The first part of the literature review looked at the risk basis of emergencies, including the organisational and public perceptions of 'what could happen'. This part of the review examines literature on emergency planning, which is one of the main tools organisations use to address risk.

This section will review literature concerned with the construction of emergency plans, the training methods used to support plan users and exercising methods used to test the plan, test the response and demonstrate performance. The section will conclude with a look to the future of UK emergency planning and response.

The aim of this thesis is to develop a framework to assess emergency management performance and capability, as stated in Chapter 1. One of the primary steps to achieving this aim is clearly to define the scope of the assessment. This chapter will determine from the literature how emergency management is performed, and what factors will influence the assessment. Chapter 3 will then explore how performance and capability are assessed in other fields, and whether anything useful can be transferred.

2.5.1 UK Regulatory regime

There are several pieces of UK legislation that require organisations and local authorities to carry out emergency planning and management. A broad duty is outlined in the Health and Safety at Work (HaSaW) Act 1974 conferring on organisations the responsibility for protection of the

'...health and safety of people liable to be affected by work activities'.

(HSE, 1999)

This is supplemented by the Management of HaSaW Regulations 1992 which clarifies the obligation of

'...employers and the self employed to identify hazards arising from their activities and make suitable arrangements to ensure they are fully controlled'

(HSE, 1999)

There are three specific Statutory Instruments that outline the duty of hazardous installations. The first of these is the Nuclear Installations Act of 1965 which states in Licence Condition 11 that installations licensed under the Act must have in place adequate arrangements for dealing with accidents and emergencies. With reference to emergency arrangements, Licence Condition

11 also demands that sites submit emergency arrangements and any alterations to the Nuclear Installations Inspectorate, consult any organisations involved and rehearse the arrangements. They are also responsible for training employees in the necessary procedures.

The Pipeline Safety Regulations (HSE, 1996) require that

"...emergency plans to be prepared for hazardous pipelines...Proper planning minimises consequences. Good planning will also optimise the use of resources emergency planning is part of an overall strategy for preventing and minimising the effects of major accidents to people and the environment."

(HSE 1996: 5)

This 'overall strategy' mentioned, is a three-part strategy for major accidents and was developed following the Flixborough disaster in the UK in 1974, and is described below.

- **Identification** – notify the enforcing authorities of the hazardous presence
- **Prevention and control** – by applying appropriate controls based on an assessment of the hazards, risks and possible consequences, the likelihood of a major accident can be minimised
- **Mitigation** – even with the best controls, major accidents will never be totally eliminated so the effects of any that do occur should be kept as small as possible. Emergency Planning is one of the principal steps to achieving this.

Steed (1998) claims that the Control of Industrial Major Accident Hazards (CIMA) regulations 1984 were first directly to mention emergency planning. CIMA was superseded by new Control of Major Accident Hazards (COMAH) regulations in 1999.

The aims of COMAH are

"...to prevent major accidents involving dangerous substances and to limit the consequences to people and the environment if accidents do occur. COMAH requires on-site and off-site emergency plans to deal with the potential major accidents for those sites with the greatest hazards. "

(HSE 1999b: v)

COMAH implements the Séveso II Directive (96/82/EC) which is the European Union legislation that replaces the original Séveso Directive (85/501/EEC). The Séveso Directive was drawn up in response to an incident in a suburb of Milan, Italy in 1976. An explosion had resulted in the formation of the defoliant chemical known to the military as Agent Orange. Hundreds of residents suffered violent inflammation of any exposed skin. The long-term effects resulted in cancer and there was immeasurable environmental contamination. The long term effects are still not fully known. There was little analysis of the risk posed by the chemicals used at the plant, and as a result, no preparation for the incident. The European Economic Community (EEC) passed the Séveso Directive to enforce risk assessment and emergency planning within hazardous industry. Site operators must take all the measures necessary to

comply with the regulations, and are required to demonstrate their compliance to the competent authority. This requirement to demonstrate compliance will be discussed in greater depth in later sections.

Sites holding or processing above a certain quantity of hazardous substances are classified as being 'top-tier'. They are required to produce site and off-site emergency plans. Site plans are produced by the organisation and off-site plans should be constructed by the Local Authority (LA) in cooperation with the site. The plans should link well, and enable a coordinated response, as detailed in *Dealing with Disaster* (Home Office, 1994). This should be ensured by a process of consultation with the public and other agencies. The regulations also state that the level of planning for catastrophic failure type incidents should be appropriate to the probability of an incident occurring.

The Civil Defence Act 1948 forms the basis of Local Authority (LA) emergency planning and management activities (Home Office, 1999). The Act was supplemented by legislation in 1983, 1986 and 1993. Until 1996 authorities were only permitted to use their funding from central government for conflict-related emergency planning. Permission was given in 1996 for civil defence funds to be used for peace-time emergencies. Vary (2001: 11) states that despite attempts to change the regulations to 'Civil Protection' in 1993, there was no change. The Civil Defence (General local authority function) regulations 1993 (1) section 6, that highlight the duty of metropolitan councils to 'Make, keep under review and revise plans, carry out exercises and arrange for training of staff and others, take preparatory steps and carry out any of these plans' legally, only refer to civil defence plans, however. Vary goes on to state that other than these core legislative requirements and the government publication '*Dealing with Disasters*' (Home Office 1994) there is no single statement of national policy concerning disaster management.

Since Vary's work the Emergency Planning portfolio has been moved to the Cabinet Office, and is now dealt with by the Civil Contingencies Secretariat. Work is underway to redefine the role and responsibility of LA emergency planning departments and regional government in civil protection, which will culminate in the Civil Contingencies Bill, which is being issued as this thesis is being completed.

2.5.2 To defend or to protect?

Alexander (2002b: 210) argues that a move towards civil protection is a necessary progression towards collaboration and information sharing. Civil Defence is associated with military and paramilitary forces, acting under an authoritarian command structure. It favours plans and strategies which are kept secret from enemy powers. Such a system is based around the withholding of information, and therefore is not totally compatible with accountability and transparency. Alexander notes that by the late 1960s, research in the social sciences had cast doubt on efficacy of using 'command and control' based military systems of emergency management.

Alexander (2002b: 209) notes that civil defence plans to protect the public from nuclear attack in 1948-9 were 'pretty useless'. Clarke (1999) goes on to

say that even now, plans to deal with and recover from nuclear disaster are based on conjecture rather than scientific certainty, and as such, bear little resemblance to reality. Clarke's work refers to such plans as 'fantasy documents' which are described as

"...symbolic documents...rhetorical instruments that have a political utility in reducing uncertainty for organisations and experts"

Clarke (1999: 13)

Dynes (1990) concurs with Alexander, Clarke and Vary in the unsuitability of the military command and control model as a basis for civilian, peacetime emergency management. Dynes' main argument describes the difference in behaviour between military and civilian populations. The former are regimented, obedient and organised whereas the latter can be fragmented, heterogeneous and unpredictable. Dynes goes on to advocate an alternative model based on continuity, coordination and cooperation which help form the foundations of research-based planning.

The military command and control model assumes that people are weak and helpless and therefore need an authority figure to command and control them in an emergency (Dynes 1990). Plans based on this model tend to have four main assertions:

Figure 2-6 Command and control assertions



Adapted from Dynes (1990)

Plans based on these assumptions try to impose a uni-directional authority on the emergency situation, whereas normality is based on multi-dimensional authority structures. Emergency plans create unfamiliar situations, which cause departure from normality, in addition to the disruption already caused by the actual disaster. There is an inferred distrust of emergent groups, which stems from the notion that the public should obey any instruction they are given, and do nothing else.

Dynes (1990) advocates the use of a problem-solving type model of emergency management, which makes full use of existing social structures in

the incident response. Using existing social structures minimises further departure from normality, and minimises disruption to the public. Dynes argues that existing social structures can evolve a more adequate response than the traditional command and control model. He considers the key advantages to be continuity rather than chaos, coordination rather than command, and cooperation rather than control. Dynes suggests the theory that behaviour before the emergency is a good predictor of behaviour in an emergency if existing social structures are used.

Alexander (2002a) suggests that there are different types of organisations in emergency response. The 'adapting' organisation retains its original structure and personnel, and adapts its operations to the needs of the incident. An 'expanding' organisation increases their complement in order to cope with the disaster, perhaps taking on volunteer workers or recalling workers on leave, or employing consultants. An 'extending' organisation increases their activities to cover the needs generated by the disaster. An example is a civil engineering company becoming involved in structural damage assessment following an earthquake. Bardo also mentions 'emerging' organisations, which are created during the incident and can include survivor and victim support associations. Examples include a group of wives who lost their husbands in the Piper Alpha disaster, and the Disaster Action group, which represents victims and survivors of several disasters in the UK. Sociologists have labelled such groups as examples of a 'disaster sub-culture'. The final group noted by Bardo are 'redundant' organisations, who have no role to play in a disaster and are discontinued by their members for the duration of the incident. They can include sporting and cultural groups.

Alexander (2002a: 104) compares the hierarchical command and control method of emergency management to the newer Incident Command System (ICS). The latter is found to be more flexible and dynamic and can change to meet new challenges and novel situations that occur in emergencies. ICS is based on an optimum structure of 'one leader to seven operators' team. The system has two main difficulties, in accounting for the person who wants to operate alone and in the difficulty of observing work from a higher level. It is however a rapid response solution, as individual teams can be set to work on a part of the response without stalling if other teams or parts of the response are not ready. This system depends heavily on structured information flow, and requires a well practiced and honed information management system.

2.5.3 Examples of overseas regulatory regimes

Dynes (1990) suggests that the UK lags behind the USA in reforming the civil defence establishment, with major UK change only taking place after the World Trade Centre catastrophe of September 11th 2001. The USA began the move away from civil defence in the 1970s, with The Disaster Relief Act closely followed by the establishment of the Federal Emergency Management Agency (FEMA). Some aspects of USA emergency management still incorporate elements of command and control however.

Steed (1998) describes the Comprehensive Emergency Management (CEM) regime which was introduced under President Carter in 1979. CEM is based

on preparedness, response, recovery and mitigation. Steed's interpretation indicates that the sequence begins with an incident, with the first stage being response. If correct, this would mean that the system had a reactive capacity, with an incident providing the motivation for preparedness measures. This is possible, but wider reading on the subject suggests that Steed has misinterpreted the sequence. Steed also mentions the goals of Integrated Emergency Management (IEM) in the USA, which are to develop and maintain a credible, national emergency management capability by integrating emergency management activities by their functions, relevant to all hazards. This 'all-hazards' approach of looking at the common management functions across all possible hazards is an important point, and is developed later in this study.

The USA also has stern penalties for organisations which do not comply with emergency management legislation. LAs and companies which do not comply are heavily fined, up to \$75,000 per violation per day for districts, and \$50,000 or 5 years imprisonment for organisations which cover up hazardous incidents.

Steed (1998) also cites the practice in Australia, which changed from a British style civil defence focus to state level emergency management organisations in 1989. New Zealand has an all-hazards approach, with a mainly civil defence and protection based system. Denmark boasts a highly trained group of volunteers. They also have a high level of technical skill, and a specialist college for staff training in civil defence, with a strong exercise focus to their training.

Porfiriev (2001) discusses the situation in Russia, where radical change followed Chernobyl in 1986 and the Armenian earthquake in 1988. Emergency management policy has existed as part of the National Development Policy for little over 10 years in Russia. There is now a relative increase in the role of mitigation, implying a gradual move from reactive to proactive flexible approach. Russia has an agent based planning system, rather than an 'all hazard' reaction based approach. Seveso II is interpreted into the 1997 Industrial Safety of Hazardous Production Facilities Act.

2.6 The emergency plan

This subsection will review literature on the construction, function and elements of emergency plans. The focus is on UK hazardous industry and Local Authority plans, however where useful comment is made on different types of plan, this has been taken into account.

2.6.1 The role and purpose of emergency planning

The UK regulatory guidance (HSE 1999) defines a Major Accident according to COMAH as

"an occurrence (including in particular, a minor emission, fire or explosion) resulting from uncontrolled developments in the course of the operation of any establishment and leading to serious danger to human health or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances."

(HSE 1999: vii)

The environment in relation to COMAH comprises of built features, water, air, soil, flora and fauna. Just as the hazard to off-site populations should have been mapped and considered, so should the hazards to the relevant environmental features. Detailed environmental risk assessment should have been carried out by the establishment. The Fire Service, the Environment Agency and specialist contractors might need to be consulted about pollution control and restoration of the environment following any incident.

The COMAH regulations (HSE 1999) give the objectives for off-site and site emergency plans as

- Containing and controlling incidents so as to minimise the effects, and to limit damage to persons, the environment and property;
- Implementing the measures necessary to protect persons and the environment from the effects of major accidents;
- Communicating the necessary information to the public and emergency services and authorities concerned in the area, and;
- Providing for the restoration and clean-up of the environment following a major accident.

In addition to the plans and procedures, the commitment of the organisation is mentioned by The Home Office (1999) in the Standards for Civil Protection in England and Wales document, stating that

"...to be fully effective, EM arrangements must have the positive support of elected members and senior staff. Arrangements should be corporately owned and all those likely to be involved in a response should feel they have an investment in the planning process and its successful operation."

(The Home Office 1999: 4)

It also states that senior staff within the local authority should have their emergency management responsibilities noted in their job descriptions, and any department or service which has a role in the emergency arrangements must also be involved in the emergency planning process.

The Home Office (1999) also give an inclusive definition of resources as

"...people, finance and equipment but also include mechanisms to access alternatives and the development of practical arrangements to contact and callout staff."

(Home Office 1999: 10)

The plan should also initiate a responsible and precise warning process for the general public and specialised groups. The structure and responsibility for warning should be detailed in the plan, and there should also be a mechanism for feedback on the effectiveness of the warning. Public warning in emergencies is a very sensitive topic, and involves politics and economics as much as it includes technical knowledge and communication. Alexander (2002b: 147) notes succinctly

"...flexibility and marriage of technical and social expertise are the key to success of the warning process."

(Alexander 2002b: 147)

Paton and Jackson (2002) enhance the definition of an emergency plan beyond the document, stating

“Plans should be based on a detailed and comprehensive analysis of operational demands, linked to action (e.g. training programmes, resource allocation, simulation exercises) and reviewed regularly.”

(Paton and Jackson 2002: 115)

The extent of emergency planning efforts is an issue of some disagreement in the emergency management field. Nuclear sites in the UK, under the Nuclear Site Licence Condition 11, must identify the most significant hazard which gives the 'reference accident' against which the site and off-site plan can be designed. Non-nuclear sectors are less prescriptive however. Terms including 'worst case scenario', 'worst credible event', 'beyond design-basis accident', 'worst credible incident' are used interchangeably, and no clear delineation is available. Ramsay (1999) offers some clarification, in noting that a plan should be capable of dealing with the largest reasonably foreseeable incidents, but detailed planning can be focussed on the more probable events, the emergency plan taking a risk-based approach. Risk-based emergency planning will be discussed further in the following section, as the literature concerning the structure and content of emergency plans is examined.

2.6.2 Structure and content of plan

The essential purpose of an emergency plan is given by Alexander (2002b) in his description of the process of planning.

“In this process [emergency planning], technology must mesh with geophysical, social and cultural factors to produce a multi-faceted document flexible and detailed enough to direct operations in a wide variety of circumstances but simple and well structured enough to be understood by a wide variety of users.”

(Alexander 2002b: 95)

Alexander also emphasises that the purpose of the plan is to inform, instruct and direct participants, highlighting two specific sections of plan. These are information management in terms of communications channels, protocols, priorities and public information and the command structure; which must be clearly structured and understood. A flatter organisational structure is favoured, incorporating parallel operational units under a single tier of strategic direction.

The merits of different plan document styles will be discussed further in the Data Analysis; however Alexander (2002b) suggests that the plan itself should be a three part document, consisting of an abbreviated synthesis of the actions, the actual planned structure of the response, and an annex containing the data and appendices. The synthesis of actions should be a document which can be used in an emergency, and provides easy access to the required information. The full section of the plan should be the main document which can be used in exercise planning and training, and with which all teams should be familiar. It may not be appropriate for reference in

an incident however. The diagram below summarises the key components of the emergency planning process (HSE 1999: 7)

Figure 2-7 Key components of emergency planning process



Adapted from (HSE 1999: 7)

The regulations also prescribe some contents of the site plan, including the details of how the plan can be initiated and who is responsible for taking charge of the site response. The plan should also include details of liaison with off-site agencies, and how they are warned and the off-site plan is activated. Details of how to control smaller events which could trigger a major accident and limiting risk to the site population are also required. Arrangements for training staff in their emergency duties, and plans for providing assistance to the off-site response are also prescribed components of the plan.

Coordination between teams and organisations is facilitated by the adoption of a common terminology. The COMAH regulations encourage this, as it aids consistent emergency planning across the country. COMAH adopts standard names for the role and responsibilities of each emergency team member (HSE 1999: 14). This uniform approach to emergency management also assists regulation.

As indicated in Figure 2-7, the operator has a duty to ensure the plan is put into place as intended. The guidance suggests that an operator can ensure this by training the emergency planners, training those with a role in the plan, detailing how the plan components will be tested & updated, and how plan components will be reviewed & revised to account for changes and lessons learned. The importance of learning the lessons from emergency response are echoed in the responsibilities of the Site Main Controller (Emergency Manager), to

“arrange for an ongoing record to be kept of the emergency and the responses undertaken to mitigate its effects, to provide evidence of the decisions made, the mitigatory action taken, and to ensure that lessons are learned from the response to the emergency.” and “Ensure that full consideration is given to the preservation of evidence”

(HSE 1999: 15)

The EM oversees the response from the Emergency Command Centre (ECC). The guidance prescribes several requirements of the ECC, including good communications links, facilities to record the development of the incident to assist incident management and decision making. Record keeping is essential for any subsequent inquiry. The ECC should have facilities to record messages sent and received, and access to data on the site population at the time of the incident. The site should also identify any circumstances where the ECC could be compromised by the incident, and if such circumstances exist, a back-up ECC should be constructed.

The off-site emergency plan for a COMAH establishment should be constructed by the Local Authority, in close collaboration with the site and the Emergency Services. It is a tool to coordinate the existing emergency services, hospitals and LA plans with the site plan. The District Off-Site Emergency Command (DOSEC) should have similar facilities to the ECC and the off-site plan based on hazards which can affect people and environment outside the site boundary. As with the site plan, it should concentrate on events most likely to occur, but be flexible enough to deal with other less probable events.

Domino sites are nearby industrial installations that could be affected by an incident at a neighbouring site. Information exchange and planning consultation should occur between these sites if it is appropriate. Where the site or consequences straddle boundaries, more than one LA may need to collaborate. If any incident has possible trans-boundary effects within the European Community then details of informing other member states should be included, as recommended in the Seveso legislation. DOSEC should have similar facilities to accommodate all off-site groups.

The National Audit Office carried out work in 2002 which assessed Health Authority emergency plans across the UK. They produced a useful checklist of the criteria for plan assessment (see Figure 2-8).

Figure 2-8 NAO checklist of emergency plan elements

Requirement	Indicators
Plan is part of a continuous process	<ul style="list-style-type: none"> • Evidence of amendment sheets, as statement as to when the plan was last updated and by whom • Evidence that the plan had been reviewed and updated since events of September 11th 2001 • Evidence of version control and a style conducive to a continuous process • Evidence of a statement to say plan is under constant review • Evidence of endorsement by Chief Executive.
Plan incorporates up-to-date national guidelines	<ul style="list-style-type: none"> • Evidence of reference to relevant guidance/legislation • Evidence of reference to legislation post September 11th 2001
Plan incorporates all elements of the trust's response as outlined in national guidelines	<ul style="list-style-type: none"> • Clear alerting and activating procedures • Clear statements of roles & responsibilities • Clear arrangements for hospital control team, Incident Management team and documents and logs • Coordinating NHS Communications at the scene • Clear procedures for initial triage • Action cards for all key staff/functions • Arrangements for relatives, VIPs and media • Clear Identification of resources for response • Clear arrangements in case of communications failure or transport disruption • Arrangements for debriefing and subsequent support for staff, patients and relatives • Arrangements for epidemiological follow-up.
Plan is flexible enough to meet all possible causes of a major incident.	<ul style="list-style-type: none"> • Plan defines and covers both external and internal incidents and identifies risks/hazards. Must refer to separate plan if it does not cover internal hazards • Plan covers CBRN incidents.
Plan is clear, unambiguous and easy to use	<ul style="list-style-type: none"> • Easy to read language and format • Plan has comprehensive index, cross-referenced as appropriate • Action cards/lists are simple prioritised and accessible • Does not require use of other documents or references not in annex • Brief & concise and contains key information only.
Plan states relationship to external organisations including NHS, their respective roles and how the organisations will interface with each other.	<ul style="list-style-type: none"> • Statement of other key organisations and their roles • An indication of the interface required, and the procedures..

Adapted from (National Audit Office 2002: 46)

The checklist mentions the events of September 11th 2001, as the UK guidance and requirements for Health Authority planning were revised in light of those events in the USA. Emergency plans were assessed on the basis of whether the indicator was satisfied, with no further detailed investigation. This gave a quick overall assessment of the state of the UK's Health Authority emergency planning. September 11th is noted as a turning point for many organisations in the context of their emergency management and business crisis planning adequacy. Many organisations have reconsidered their remit for emergency management, and the scale of events they need to plan for. The scope and focus of emergency plans for other industry is not well defined, and will be discussed further in the following section on risk-based emergency planning.

2.6.3 Risk-based emergency planning

Mountain (2002) suggests that strategically based emergency plans should drive, but also be informed by, the operational response during major accidents and incidents. He defines risk-based emergency planning as being based on the full range of credible accident scenarios, which have been analysed in terms of consequences. The plan should provide different response strategies specifically for the purpose of addressing the different major accident consequences. The plan should also ensure that the potential consequences are well understood and can be acted upon through appropriate responses.

The previous section of Chapter 2 discussed the broader field of risk, and the conclusions of this chapter will integrate some of the important concepts of emergency planning with key lessons from the risk literature.

The focus of risk-based emergency planning is that the plan is based on a measured representation of the risks, rather than on one hazard or a single 'worst credible event'. There is an assumption that by planning for the worst case, the organisation and the plan would be capable of dealing with any lesser incident. This is not a sustainable basis for planning an emergency response, and the alternatives will be argued later in this chapter.

2.6.3.2 Human aspects of emergency planning

The Disasters Working Party report (1992) notes that the needs of the 'disaster affected' are quite well documented, however the ways of meeting those needs are not. The Home Office (1999) state that beyond the duty to plan for emergencies

"Authorities will also need to consider the human, or emotional aspects of a community's recovery from a major incident and the part that elected members and the media might play in the restoration and rebuilding of the community."

(Home Office 1999: 9)

Alexander (2002b: 188) emphasises how good emergency plans should account for vulnerable sectors of the community, namely the young, the old, the sick, those who are imprisoned, asylum detainees and the mentally ill. Alexander also advises caution in dealing with bereavement and death in emergency plans. This is an area where consultation is essential to find the

most appropriate and acceptable solution, especially with respect to diverse faiths and cultures.

The remit of the Disasters Working Party (1992) was to provide guidance on meeting the social and psychological needs of those affected by disaster. The group was made up of the Department of Health, Local Authorities and bereavement counselling groups. The report reviews current good practice and experience, and provides guidelines for an action plan. Its remit considers that the majority of UK experience is from man-made incidents rather than natural disasters. An interesting comparison, but beyond the scope of this thesis, is the difference between human reactions to natural and man-made disasters examined by Hodgkinson and Stewart (1995).

The approach of the working party supports Dynes' (1990) work, which recognises the value of using established social groups as the foundation of the response plan. It states that primary support for individuals is likely to come from their friends and relatives and community, and that any formal response is to complement that. They define complementary support as emotional and practical support given by individuals who have been selected and trained for this purpose (Disasters Working Party 1992: 3).

The report also comments on the lack of learning which has taken place after many of the disasters it reviewed.

"Although reports on some of these disasters have been published, little has been done to draw out the useful lessons from dealing with trauma in a disaster aftermath."
(Disasters Working Party 1992: 3)

The working party states that studies in USA and Australia following both natural and technological disasters reveal that between

"40% and 70% of those directly involved in an incident, experience psychological distress and impairment during the first month following the disaster"
(Disasters Working Party 1992: 3)

This figure drops to 25-40% after one year has passed. This highlights an important point for emergency planners. Bereavement and psychological care following a disaster situation are not a short-term commitment, nor can their importance to be taken lightly. The trauma following a disaster brings about post-traumatic stress (PTS) which has implications for the physical and mental health of the victim. If left untreated, the temporary effects of PTS can escalate to the more permanent post-traumatic stress disorder (PTSD) which has deeper and more long-lasting implications for the sufferer.

It is clear from this section that an emergency plan should recognise the need for, and provide appropriate levels of, psychological support within a short time-frame after the disaster has occurred. This rapid action needs to be instituted and planned before the incident occurs. It should be noted at this stage that where children are involved in an incident, there is a critical time-frame in which psychological intervention should be made. This is discussed further by Hodgkinson and Stewart (1995). It is also clear that full use of the

existing structures and systems of social care should be made, in order to ensure a coordinated and sustainable response.

Alexander (2002b: 127) draws attention to the protection provided by a good emergency plan. It guards the organisation, emergency planners and owners of the response against unnecessary exposure to risk of prosecution. The quality of the plan can also be an important factor in matters of liability, insurance and the corporate responsibility of the organisation.

A second means of shielding the organisation from legal accusations and damaging publicity in a crisis is carefully to plan the media response. It is good practice to prepare news-ready background footage of the organisation and information on its sites and business to inform media if anything happens. Prepared press-releases are also important, and can take the pressure off during the first hour of response. Media information must be accurate, consistent and timely. Having the media response as part of the emergency plan ensures that this important aspect receives due attention, and is implemented efficiently. Further work on media emergency planning can be found in Deacon and Deacon (1999).

An important aspect of any emergency plan is that it avoids discrimination. In this context, Alexander (2002b:127) refers to the rights of women throughout the emergency planning process. Consultation with a representative sample of any population or workforce should ensure that the plan does not inadvertently discriminate against one group. The special needs of pregnant women and those with new babies should be considered, noted by Clarke (1999) as especially relevant to nuclear emergency planning, as even small doses of radiation can have a harmful effect on the unborn child and infant. Female head-of-households, orphans and culturally or religiously defined groups (for example Indian castes) should also be considered in societies or cultures which discriminate against them. The aim of the plan should be to protect all those at risk, regardless of their background, sex, race or culture.

2.6.4 Revision and updating

"Emergency plans are 'living' documents. They should be kept up to date..."
(HSE 1999:10)

Although the HSE guidance states the intention of continuous improvement, it fails to describe how to achieve this. There is no detail given on practices that enable an organisation to learn from response, or capture the knowledge and lessons and integrate them into future planning and development. As COMAH encourages much more of a common structure, a common language of emergency management can now be expected across the UK hazardous industry, which facilitates common sharing of experience and knowledge, if the learning mechanisms are developed and put in place.

Alexander (2002b: 128) agrees that plans should be dynamic in nature. His work emphasises the need for a review of the plan at least once every three years, and should take into account changes to the activity or layout of the

organisation or site, staff or the emergency services and organisations with which it interacts. New knowledge from research or lessons from exercises and other incidents should be incorporated into the plan to ensure that the best available techniques are available to the response. The revision of the plan should also include changes which have taken place outside the organisation. Environmental and infrastructural changes can affect wind direction around a hazardous site, and changes to watercourses could open new routes for pollutants to enter sensitive areas. Population movements, growth and change of demographics can also affect assumptions made in an off-site emergency plan. A good plan will have safeguards in place to ensure that any changes to the site or off-site should be risk-assessed and incorporated, and continually improve. This is discussed further in the following section.

2.6.5 Continuous improvement

Continuing his argument for the use of existing social structures in emergency situations, Dynes (1990) cites the advantage of improved learning capacity. Established systems can learn from the emergency and develop during the inter-incident period. They are then better equipped to cope with the next incident.

The Home Office (1999) also supports a continuing commitment to response improvement. It recommends a programme of training and exercising which includes opportunities for training with external organisations. To facilitate improvement, the programme should continually be evaluated and following exercises action plans should implement the lessons learned. They recommend the use of qualitative and quantitative measures of success, but give little detail regarding the methods of evaluation or means for continually improving.

Alexander (2002b: 130) discusses ways of assessing an emergency plan's functionality. He supports the use of field exercises as part of this assessment, providing that they are thoroughly debriefed and the results recorded accurately. Alexander also advocates the use of data from live incidents in enhancing and developing the planning process. Logs and records of the incident progress should be kept by a nominated member of staff, who in appropriate circumstances can be assisted by computer software designed for this purpose. It may also be useful to consider near-miss incidents, and extrapolate the consequences as a test of the emergency plan. This is especially useful for discovering links between the trigger events and the underlying unsafe conditions, which combine to create an incident. This concept is formally described as the Pressure and Release model (PAR) by Blaikie et al. (1994).

The need for dynamic plans is recognised by Toft and Reynolds (1994: 79) using the example of a building which changed use, but did not change its safety precautions to support its new role. Toft and Reynolds also note the change of use from a large house into an old peoples' home. The authors cite the Fairfield Home incident of 1974. A fire destroyed the building, killing 18 residents. One of the main reasons for the rapid spread and high death toll of

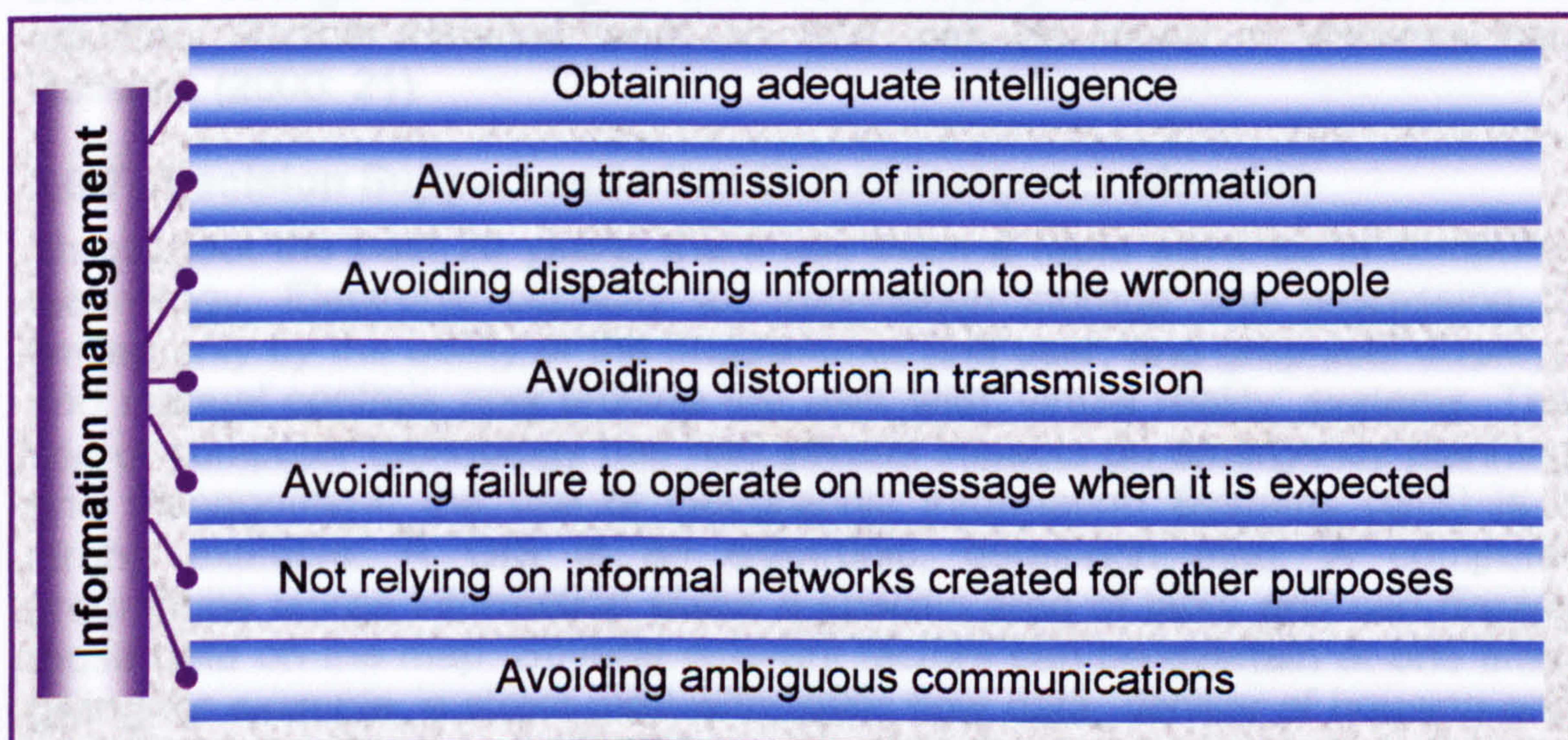
the fire was the polyurethane foam armchairs, which created vast amounts of dense toxic smoke. The fire exits and emergency lighting in the building had not been altered to take account of a new layout and occupancy. A contributory factor was the fact that for the comfort of the residents, the central heating in the building had been at a particularly high level for a number of years, which had effectively dried out the fabric of the building making it much more flammable. The example illustrates the need for flexibility and innovative thinking in emergency planning, as well as a continuous approach to plan updating and continuous risk analysis.

The emergency plan may need to be implemented at any time. For this reason, it must be kept up to date and current at all times. The specific parts of the plan that refer to its implementation are discussed in the following section.

2.6.6 Information management

A key task in emergency management is dealing with information in a structured and orderly manner. Turner and Pidgeon (1997: 55) consider the problems of managing the vast amounts of information which are generated during an emergency. They give seven aims of good information management in an emergency.

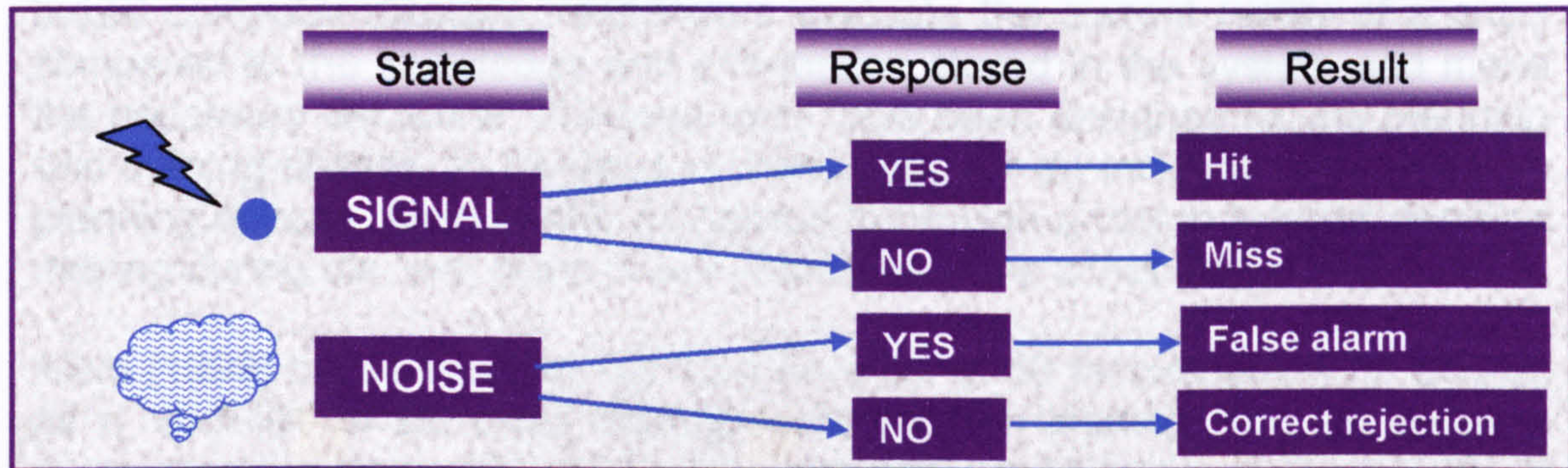
Figure 2-9 Information management in emergencies



Adapted from (Turner and Pidgeon 1997: 55)

Alexander (2002b: 94) notes the importance of four aspects of communicating emergency information. These layers in the process are the technology, the procedures, the human factors and the organisational context in which the communications occur. The science of information communication is discussed by Wickens and Hollands (2000).

Figure 2-10 Signal Detection Theory diagram



Adapted from (Wickens and Hollands 2000: 18)

Figure 2-10 is a graphical interpretation of the Signal Detection Theory (SDT). There is a broad psychological literature associated with the SDT; however it serves a useful purpose for emergency planning in its basic form. If information management tasks are considered with the above four outcomes in mind, communications can be managed to ensure that signals are clearly broadcast and confirmed, and noise is reduced. This applies to radio messages, verbal messages between individuals, the man-machine interface between the operator and any warning alarms, lights or displays, and written messages coming into the ECC. To increase accuracy of signal detection, both the strength of the signal and the sensitivity of the responder can be adjusted. Further detailed work on SDT can be found in Wickens and Hollands (2000: 21)

2.6.7 Decision Support and other IT for emergency planning

Throughout the past 20 years, there has been a rapid advance in computer technology. Electronic capacity for information storage and processing is limited only by the ability of the programmer and user, and graphical displays and manual controls now provide the user with 'virtual reality' systems. The use of computer technology has had several impacts on emergency planning and management, the use of Geographic Information Systems (GIS) is a strong example. A GIS is an electronic, detail-rich map. A computer programme stores information about a specific area of land, and can display those data on the map. Several different factors can be overlain at one time, giving for example, a street map with traffic flow data, density of housing and population demographics. Real-time information such as wind direction and vehicle flow can be displayed, and additional software can plot the movement of chemical plumes over an area, taking into account meteorological conditions and the built environment layout. An example of such a system is the USA National Oceanic and Atmospheric Administration (NOAA) computer-based emergency system called CAMEO (Computer Aided Management of Emergency Operations), which is software to plot plume-dispersion patterns. (Lillibridge 1997: 365). GIS is also widely used by UK emergency response services to plot safe routes of approach to fires and chemical leakages, and plan evacuations.

Aleid's thesis (1999) develops a Group Decision Support System GDSS for crisis management. He describes the GDSS as a framework to support

knowledge enhancement in both the scenario and the planning stage. Using linked computer displays, responders evaluate the current reality of a crisis compared to the knowledge and information stored in the system and make the necessary decisions. Previous tools have been designed for the planning and training phases, to be used in preparation for an incident or in exploring planning options. Aleid (1999: 51) aimed to provide a tool to support decision making during the 'live' crisis phase, which he terms a 'hot tool'.

Aleid (1999) bases some of his work on a list of 56 factors which he defines as a 'wish-list' to aid crisis management decision making. The list contains some practical and valid points; however one would question the validity of transcendental meditation as a suitable strategy for use during a crisis situation.

Although decision support should aid decision making, the ease with which it provides information can be adjusted to enhance creativity, notes Aleid (1999). The mechanisms and interfaces must not allow quick and unconsidered decisions to be made by the user; rather the DSS should introduce an aspect of 'conceptual discomfort'. This will help ensure that the decision maker justifies the solution and has considered the available alternatives. The use of innovation in emergency response will be discussed later in this thesis.

De Silva (2001) describes an IT based Spatial Decision Support System (SDSS) called the Configurable Evacuation Management and Planning Simulator (CEMPS). This tool is a GIS combined with a DSS, and was designed as an interactive planning tool. Scenarios can be analysed using the system, and the planner can alter elements of the evacuation and observe the effects in the simulation. CEMPS allows various assumptions to be used regarding evacuee response delay and traffic flow data for example, and is flexible to allow the user to work at different levels of detail.

Also of interest is the joint European project called 'MEMbrain', which involves the development of an integrated software platform for major emergency management. The platform would support a GIS and a decision-support system that will aid public protection and off-site emergency management. It is also incorporating an interactive triage training module for medical doctors. The project is partially funded by the EUREKA programme and is ongoing (Risø 2002).

It is clear from this section that the purpose of a DSS is to support a human decision maker, and must offer a level of guidance that informs the user in making a structured and accountable decision. The DSS does not give the answer to a situation, whereas the computerised control systems of aircraft and nuclear facilities can take command of the situation and make the necessary adjustments to bring the system back to safe parameters, or shut it down.

De Silva (2001: 17) also cites a point of caution, asserting that as the real world is dynamic, its problems and systems should also be dynamic. Models

can not always be validated against the real-world system they represent, because the real-world system continually evolves while models can often remain static.

2.7 Training

An emergency plan is of little use unless the people with roles to play and responsibilities in the response are trained to carry out their assignments. This subsection will briefly review the emergency management training literature.

2.7.1 Purpose of training

The subject of emergency management training is difficult to review succinctly, as there are many aspects which are subjects in their own right. In the context of this thesis, an examination of the vast psychological literature relating to training theory, learning and memory (Wickens and Hollands 2000) and leadership training (Flin 1996) would be unwarranted. The texts cited above give a robust introduction to those subjects, and provide detailed reference to the subject from the psychological perspective. This study proposes therefore to focus on the role of training in relation to emergency planning, and issues specific to emergency management training, and how they are commonly addressed.

The role of training in emergency management is important, as it is a legislative requirement. HSE (1999) notes that a COMAH site must show evidence that its Safety Management System includes suitable arrangements for training individuals in emergency response. The type of training should cover the appropriate roles, and should be maintained. Training should also be carried out to defined objectives, and effectiveness should be reviewed and evaluated.

An interesting point is noted by Bolk et al (1997) citing Levy and Merry. He makes the point that only people can learn, and what they learn can be embedded in computers, however everything else is a construction of human endeavours. He offers three degrees of learning, the first being that existing viewpoints are reinforced by the processing of information (no change to viewpoints). The second results in the slight amendment of existing viewpoints by the additional information (first order change), and the third results in the radical alteration of viewpoints (second order change). Since Bolk's work, advancement in the field of artificial intelligence has been such that computer systems can now adapt their programmes to new information and also recognise and react to patterns and changes. This could be defined as learning, although the capacity to carry out that activity has ultimately been created by a human programmer. The dictionary defines the verb 'to learn' as

"...to gain knowledge of or skill in... to come to realise or know"

(Allen 2002: 503)

It could be noted that with advancement in the fields of knowledge capture and knowledge management there is now a stronger argument in favour of organisations having the capacity to learn, in the literal sense. If learning is the gaining of knowledge in a certain area, and an organisation has the means of

ensuring that any knowledge benefits, and is retained by the wider organisation, then the organisation has learned. The way in which the organisation responds to the experience and knowledge of the individual can be labelled as organisational learning, whereas the way in which individuals respond to the learning and change is connected more to the organisation's culture. In a key management text, Handy (1993: 180) defines organisational culture as

"...-cultures – sets of values, norms and beliefs – reflected in different structures and systems. And the cultures are affected by the events of the past and the climate of the present, by the technology of the type of work, by their aims and the kind of people that work in them."

(Handy 1993: 180)

Organisational culture is an important concept to the study of emergencies and disasters, and holds a prominence in many UK disaster inquiries. Fennell (1988) alludes to the culture of the railwaymen in the Kings Cross fire. The senior members of London Underground staff had all reached seniority through internal promotion. Little or no influx of new staff at managerial level can indicate stagnation of thinking and unwillingness to change. This was the case at Kings Cross, where there had been no change in the way the workers treated a fire or 'smouldering' located at an inconsequential location on the track, and the way they treated such an occurrence at a safety-critical location on the stations. Fennell (1988), in concluding the Kings Cross enquiry, states that "London Underground has accepted that a cultural change is required throughout the organisation"

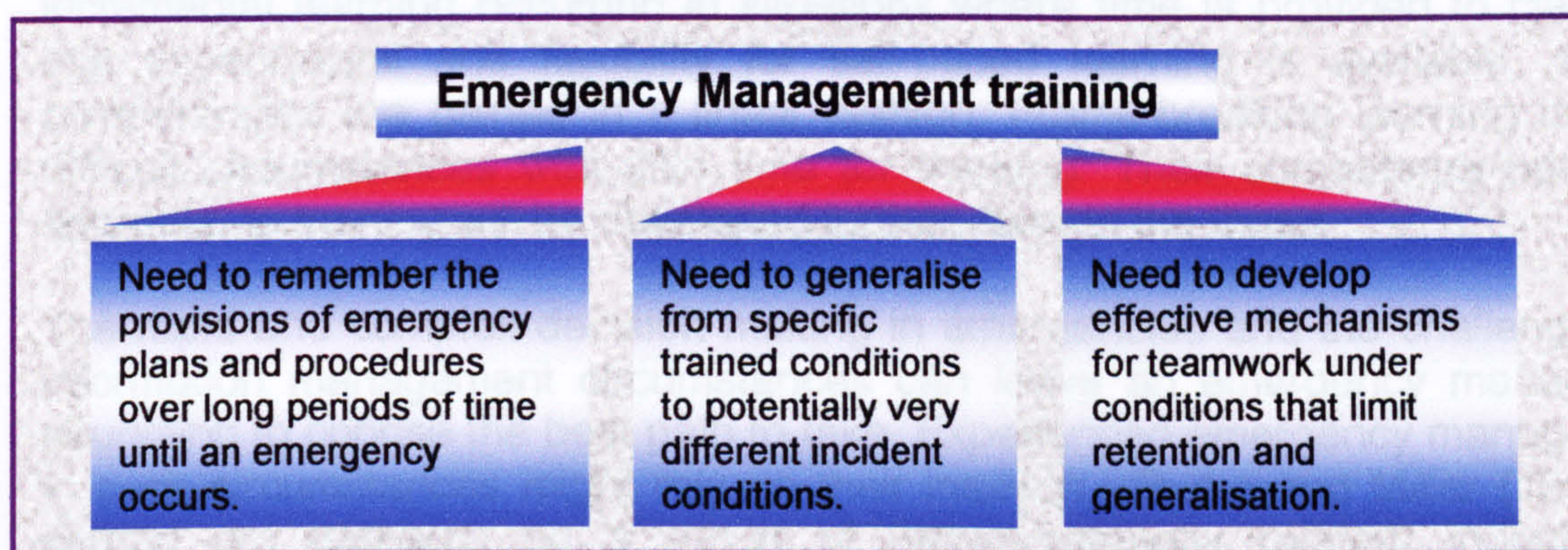
Skriver (1998) cites the Piper Alpha oil platform disaster of 6th July 1988 in which 167 people died. The system of command on the installation had broken down. Senior staff were unprepared for the type of emergency that occurred. Lord Cullen's Enquiry into the disaster cites the lack of commitment to emergency training. Concluding the Piper Alpha enquiry, Cullen (1990) notes "it is essential to create an atmosphere or culture in which safety is understood to be, and is accepted as, the number one priority".

This section has illustrated that training alone will not ensure capability. The culture of the organisation must enable the individual to learn from the organisation, and the organisation to gain knowledge and benefit from the experience of the individuals. For training to be effective, it must be conducted in a receptive organisational culture. The specific problems of defining, delivering and maintaining such levels of training are discussed in the remainder of this section.

2.7.2 Problems with emergency management training

Ford and Schmidt (2000) introduce three unique problems of emergency management training that are not encountered in other areas of training.

Figure 2-11 Emergency Management Training Problems



Adapted from (Ford and Schmidt 2000)

Most mainstream training methods assume that skills learned in training will be put into practice and honed through application. There is limited opportunity to apply emergency management skills, and so the training requires a different focus.

The second illustrated problem recognises that while training provides the trainee with certain solutions to specific problems, the emergency situations can often deviate from the training scenarios. This leads Ford and Schmidt to define two types of expertise. Routine expertise is the internal capability quickly to apply solutions and strategies to well learned and familiar contexts and situations. They state that while it is necessary for success in the job, focussing on routine may impair ability to address a novel task. Adaptive expertise is defined as simultaneously integrating multiple sources of knowledge for use in addressing unfamiliar situations and changing conditions. It requires a deeper conceptual understanding, and an ability to recognise that a novel situation requires deviation from the routine procedures. Adaptive experts realise that the most significant developments in learning and continuous improvement require connection across people. The third illustrated problem is that emergencies demand a coordinated response from teams of interdependent members. This puts extra pressure on the coordination capabilities of the teams, and introduces further complexity into the training. This issue is exasperated by the fact that most industrial emergency management teams do not work together on a permanent basis.

Their work is based on nuclear reactor emergency scenarios, and they criticise current emergency management training practice because it tends to focus on narrow technical and job competency, whereas system and interpersonal skills also need to be addressed. They define learning as

"...involving the building of technical/job competencies, interpersonal/relationship building competencies and system/process competencies."

(Ford & Schmidt 2000: 96)

Ford & Schmidt (2000) advocate active learning which involves providing learners with control over their own learning. They give three examples of learning types. Experienced based learning works on the theory that job

activities invoke continuous improvement and learning. They describe incremental learning occurring in situations where time is provided to clarify role expectations and flexibility for self-paced learning is available, and competencies are gained in a linear fashion. Frame-breaking learning is in difficult circumstances with little time for thinking. Their competency-based approach to training will be developed further, later in the thesis.

The rapid and complex decision making in emergencies and the challenging information management circumstances can leave an emergency manager struggling to choose the best path to take. Experienced emergency managers in such circumstances might rely on their intuition. Burke and Miller (1999) carried out research on a group of (non-emergency related) industrial professionals in the USA. His aim was to examine the use of initiative in work situations, a relatively unexplored area in the literature.

"Training and experience are the fuel and then intuition and deduction are the engine. You put those two together and you end up being able to move forward."

(Burke and Miller 1999: 93)

When asked how often they used intuition in their workplace, 30% said sometimes, 47% said often and 12% said always. The majority claimed to use their intuition where there were no predetermined guidelines to follow or the objective data did not seem correct. Burke and Miller add that intuition is most appropriate when decisions need to be consistent with an organisation's culture and values, when time is short, when explicit cues from policy and guidelines are lacking, when uncertainty prevails and when the problem requires a balance of intellect and cognitive skill. These characteristics reflect an emergency management situation rather well. Burke and Miller (1999) state that intuition might be used when quantitative data are lacking, or in cases of extreme information overload.

Paton and Jackson (2002) advocate the use of assessment centres for emergency management training. Assessment centres allow both the specific aspects of complex and multi-faceted emergency management roles and tasks to be developed and practiced individually and, by using multiple exercises and simulations. They also provide an opportunity for participants to foster a more holistic appreciation of the overall disaster management role.

Assessment centres facilitate the development of core cognitive competencies that are fundamental to emergency performance; specifically they develop tacit knowledge and self-efficacy.

Peterson and Perry (1999) support this view, stating that the experience of an exercise shapes the responders perception of the emergency management system and their capability to deal with the threat. Paton and Jackson (2002) also found that assessment centre participation had a positive impact on candidates' self-assessments, which persisted over time, and suggested that this was instrumental in increasing individual and collective levels of self-efficacy and task performance in crisis situations.

2.7.3 Leadership and team competency

Ramsay (1999) describes an alternative means for organisations to learn to manage emergency situations.

"Because large-scale crises threatening the entire business are not frequent, learning from experience must be replaced by competence-assurance based on systems thinking, on risk assessment, on wide scenario simulations and on rigorous training."

(Ramsay 1999: 131)

His recommendations highlight a need for a competence-based approach to emergency management training. Competence is defined by Sandberg (2000) as not *all* knowledge and skills, but those required to do the job. The benefits of a competence focus were first brought to the fore by Taylor in 1911 (Mullins 1996), who published his 14 scientific principles of leadership.

"Taylor demonstrated that managers could set up systematic training and development activities that yielded improvements in workers' competence and consequently, increased effectiveness in organisations. "

(Sandberg 2000: 10)

Competence is primarily seen as composed of the knowledge, skills and abilities of the individual. As competencies are generic and often context independent, they can form part of many different work activities.

Three models of emergency management training described by Alexander (2002b: 290) help clarify what is meant by competence-based training. The first model is the cause-effect curriculum, which is based on dealing with particular types of disaster from cause through to effect. The second is a concept-based approach which approaches training through the concepts of planning, vulnerability, prediction, warning and logistics, with the type of emergency being less relevant. This is the most competence-focussed model, as it does not focus on the agent causing the incident; rather it focuses on the skills and knowledge to respond, elements of which will be generic across many incidents. It is sometimes known as the 'all-hazards approach' as it builds competence which can be applied to all hazards. The final model is the Scenario-based curriculum, which is entirely focussed on training for specific incident scenarios.

Flin & Slaven (1996) note that the Cullen enquiry into the Piper Alpha disaster (1990) cited poor training and inadequate leadership capability as causal factors. Thorough selection of Offshore Installation Managers (OIMs) was recommended. Skriver (1998) cites the Offshore Installations (Safety case) regulations 1992 which state that there should be

"...adequate provision for: a) establishing and maintaining a command structure by competent persons throughout an emergency, including arrangements for people who become disabled;"

(Skriver 1998)

As discussed earlier in this section, the command and control model of emergency management is looked upon less favourably for use in civilian

incidents. On an offshore platform however, the need for very rapid decision making and the limited options for survival action require the security and speed of an authoritarian response.

Different models of leadership and authority are relevant in different situations; however there should be a strong team focus in emergency management, partly because of the benefits of a common view and understanding of the situation. Flin & Slaven (1996b) advocate the benefits of a shared mental model of the situation amongst team members. They refer to 'cross training' where members learn about the roles of other members, with the ultimate aim of becoming more aware of each others' roles, rather than intersubstitutability.

A method of training which can assist in building common mental models throughout an emergency team is an IT based system. Many such systems are information based, and ensure consistency in communication of information to different team members. The following section briefly examines examples of IT based training systems for emergency management.

2.7.4 Role of IT in EM training

QinetiQ (2002) describe their simulation software known as TUTOR (definition of this acronym is not given in the paper) which has been designed to train, test and develop management skills, and as a tool for operational planning and performance analysis. The authors claim that it can be used as a simulation to predict effects of an event, or as an interactive training (gaming) facility to practice resource management. No evidence is given of successful application of TUTOR, results from use as a training tool or details of how it was constructed, so the claims of the authors can not be substantiated.

Command And Control Training and planning using knowledge-based Simulations (CACTUS) is described by Williams (1996). The software project was funded by the Department for Trade and Industry and New Scotland Yard to simulate public order offences and assist the police in planning and training. CACTUS uses multi-media case studies and GIS scenarios, and has an integral logging system. The concept of CACTUS is good; however its aims are to test the routine tasks the police might face, rather than developing their capability to deal with novel concepts, so the model is unlikely to be valuable if transferred to the emergency management domain.

It is recognised that IT based systems are used by private EM training consultancies in the UK, but despite requests, there is insufficient information available on these systems for this study to comment on their efficacy.

2.8 Exercising and testing the plan

In order to keep the emergency plan and trained personnel current, the common practice is to carry out simulated emergencies, or emergency exercises. This subsection will review the reasons behind exercising and the types of exercise available, and discuss some of the problems encountered with emergency exercising.

2.8.1 Purpose of exercising in emergency management

“Exercises may be seen as a form, perhaps an extension, of training in the sense that individuals are rehearsing response measures. ”

(Peterson & Perry 1999: 243)

Peterson and Perry's study (1999) is based on exercises carried out by a Fire Department in the USA. The purpose of their work was to investigate the value of exercises to their participants. The authors tested the perceptions of a fire crew before and after an emergency exercise. As a control group, they also tested the perceptions of crews who had not been involved in the exercises at the same intervals. They used a hazardous materials exercise and a medical triage exercise for the study.

“Often the utility of the exercise depends in part upon the participant's (emergency responder's) perception of its 'believability', which itself hinges upon the realism of the scenario”.

(Peterson & Perry 1999: 244)

Scenario realism can often be misinterpreted to mean that the scenario has to incorporate expensive measures to make it look, sound and smell like the real event. Realism is found in the pace of the exercise, and is created by the ownership and the commitment of the players. Creating realism, to an extent, can only be partially achieved in the planning stage. The realism depends on how the exercise is performed by the players. Peterson and Perry (1999) concluded that the exercises shaped the respondents' perception of the emergency management system, and its adequacy. The exercises also affected the respondents' views of their own capability and the capability of their equipment and team. The detailed results appear later in this section. They summarise the study suggesting five principal benefits of disaster exercises (Figure 2-12).

Peterson and Perry's work illustrates useful points, including the differences in emergency and disaster terminology between the USA and UK. Fire response in the UK would not be referred to as Emergency Management, whereas in the USA it is. Although their work looked at operational fire response, the conclusions on emergency exercises appear to hold true for emergency management in the UK, and will be discussed further at a later stage in this chapter.

Figure 2-12 Benefits of disaster exercises.

Benefit of disaster exercise	Explanation
Inferential testing of the adequacy of the disaster plan	An exercise represents an event response designed using premises and resources described in the plan, the extent to which the exercise is successful demonstrates the efficacy of the plan.
Exercises allow – again by inference – testing the adequacy of training of personnel	Involve incident scenarios that are intended to replicate the demands on knowledge, skills and abilities posed by real events, and which an effective training programme should create.
Exercises may be publicised in the community consequently enhancing the visibility of the agencies involved (demonstrating their readiness and possibly increasing their public credibility)	Reassuring the public that the emergency authorities are aware of dangers and prepared to take measures to reduce negative impacts.
Exercises provide “hands on” checks of communications systems, equipment and other materials	<i>*Ensures readiness and suitability of equipment.</i>
Well designed exercise tests the viability of the emergency response network relative to the threat exercised.	<i>*Supports the accuracy of the risk assessment.</i>

**Not part of original source, added for clarity.*

Adapted from (Peterson and Perry 1999)

The National Audit Office (2002) commissioned a report to determine the status of NHS emergency planning. One of the aims of this report was to consider the adequacy of emergency plan testing. Health Authority emergency plans were examined and the results indicated that one third of the Authorities were not prepared, in terms of testing their plans. Visits were made to the authorities to validate questionnaires and these indicated that the Authorities had

“...over-stated, in key areas, their degree of preparedness to tackle major incidents, or could not provide evidence of claimed improvements...”

(National Audit Office 2002: 3)

The report recommended that Authorities

“...pursue options for better knowledge management in planning for and reporting on major incidents...should include better collection and dissemination of good practice.”

(National Audit Office 2002: 6)

The collection and dissemination of good practice and the issue of knowledge management in planning and reporting on major incidents are factors which result from a thorough and well supported programme of exercising. Further details from this report will be discussed later in this section.

2.8.2 Types of exercise

Peterson and Perry (1999: 244) identify three types of exercise which they call table-top, functional and full-scale. Table-top has the advantage of being able to stop time for ‘Time-out’ evaluation and a progress review. Functional exercises test one or two functions of a wider response scenario, for example

the medical and fire response. They are usually conducted in real time. Peterson and Perry state that in the USA they would usually employ actors and field elements in this category of exercise. In the UK that level of resources would only be considered for a full simulation, or live exercise. Full scale exercising provides the total response experience, which is, however, resource intensive.

The Home Office (1998) states that the type of exercise should “provide the most appropriate and cost effective way of achieving its aim and objectives.” It also shares common recommendations with Home Office (1994) and HSE (1999) in stating that there should be a set of debriefings, concluding with a multi-agency debriefing. Hot and cold debriefing reveal different things and both are helpful. Hot debriefing takes place immediately after the exercise, and cold debriefing takes place some time after. Neutral debriefing coordinators can be useful too. They should be non-threatening, and simply act as impartial chairmen to allow everyone to contribute. The purpose of debriefing should be to share outcomes and identify future training needs.

The Home Office (1998) also states that a final written exercise report is good practice and proves the value of the exercise. It also ensures that the teams and the organisation get the best out of learning. The report should be brief and well presented. Recommendations should be followed with action and a follow-up report compiled six months later. This is a way of sharing expertise throughout the emergency planning community.

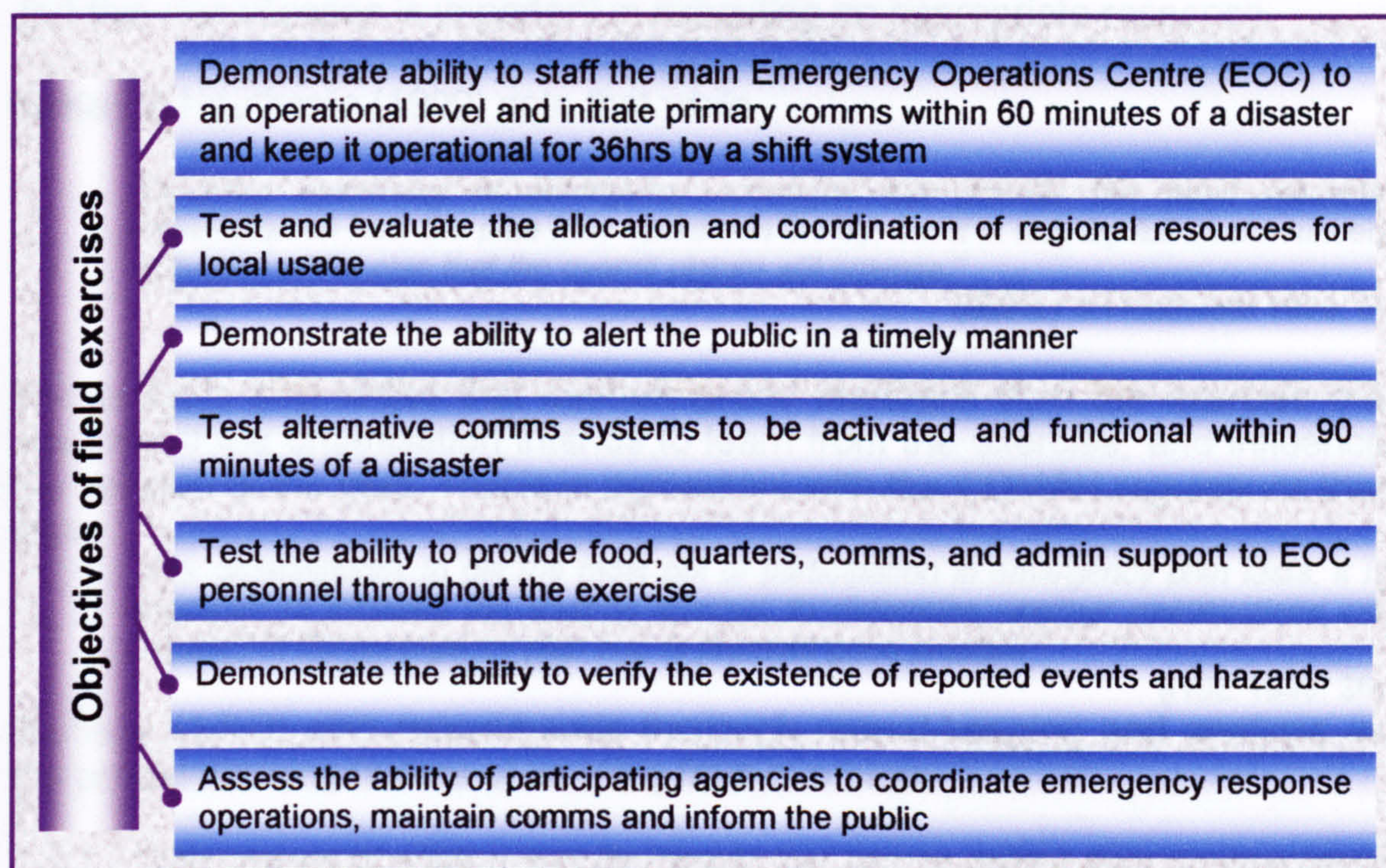
2.8.3 The process of exercising

The COMAH regulations demand that site and off-site plans are tested at least once every three years (HSE 1999). The test should indicate that the plan would work as intended, and the initiating measures would lead to the necessary mitigation, control and restoration of the environment. The test should also be based on a scenario that is built from an accident that has been identified in the safety report as being reasonably foreseeable.

Alexander (2002b) gives some objectives of civil protection in field exercises (illustrated in Figure 2-13). A number of the objectives have numerical targets. They are otherwise quite broad and should provide a substantial feedback on the performance of the team and the plan. Predetermined targets and objectives are an essential element of exercising. With targets in place, the exercise can then be evaluated once complete.

The HSE (1999) state that the objectives of plan test should be to give confidence in the completeness, consistency and accuracy of the emergency plan and other documentation used by response organisations. The test should also provide reassurance of the adequacy of the equipment and facilities and their operability under emergency conditions. It should finally reinforce the competence of staff to carry out the duties identified for them in the plan, and demonstrate their ability to use the equipment and facilities in an emergency situation.

Figure 2-13 Objectives of field exercises



Adapted from (Alexander 2002b: 88)

HSE (1999) give a comprehensive list of exercise types. The most basic is a drill, defined as testing a relatively simple and specific aspect of the plan in isolation. Seminar exercises focus on a discussion environment to train staff and develop the plan, whereas walk-through exercises examine the response in slow-time. Table-top exercises test the information exchange within and through the ECC, and practice dissemination and decision making. They are usually not dependent on vast quantities of resources, and use a site plan or model or an IT representation of the scene as the main focus. Control post exercises test communications facilities in real-time, using the actual positioning and functioning of the equipment, with appropriate staff that would be present in an emergency. The most resource intensive scenario is the live exercise, which fully tests some or all aspects of the emergency plan for the site and off-site response. Live exercises are almost always in real time.

Rasmussen & Grønberg (1997) highlight the need for emergency managers and risk analysts to exchange information and experience. These authors' work aimed to develop a model for translating knowledge and experience from risk analysis and accident investigation into emergency scenarios for training. The study focuses on the Uncontrolled Flow of Energy (UFOE) concept, defined as the state of a substance which has stored energy in terms of tension, pressure or heat in its confined state. The energy is safe when the pressure is confined in a vessel and the tension within a structure, but once control is lost, the energy becomes unconfined and hazardous.

The authors defined two types of accident. Static accidents are where there is one 'bang' and no further escalation of consequences, and a dynamic accident is an ongoing escalation. This further divides into static and stable,

and static and unstable. It can be difficult to categorise accidents sometimes, but this classification is important in executing an appropriate response.

McKay & Heathcote (1999) note that while

"Desk-top exercising of emergency scenarios will provide the most valuable information on how the plan may operate in theory, but it is only by full unannounced activation of the plan that the overall picture will emerge."

(McKay & Heathcote 1999: 8)

The authors also stress that debriefing and feedback from the exercise are essential if the organisation intends to learn from the exercise, and influence the revision of the plan. This is in agreement with the COMAH regulations that state

"For organisations to get the most out of participation in emergency plan tests, it is important to evaluate the lessons learned, to determine whether modifications are required to the emergency plan and to promote good practice"

(HSE 1999: 36)

Ramsay (1999) also recommends thorough record-keeping and analysis as the predetermining factors of learning from exercises

"The amount of wisdom and the benefit that can be gained from an emergency exercise is highly dependent on the quality of the recording for subsequent analysis."

(Ramsay 1999:137)

It is possible that different organisations involved in an exercise will use different evaluation methods, and each may want to establish its own measures of the response, for example quantitative measures such as timeliness or subjective measures such as quality of performance. It is important that the evaluation include a means of sharing the lessons between the organisations, and ensure that information regarding recommendations and action plans resulting from the exercise is kept updated and the organisations are kept informed of progress.

2.8.4 Outcomes from exercises

Aleid (1999) defines principles for enhancing creativity in decision support systems. Mead suggests that depth & tenor of feedback enhances creativity. Aleid states that nice, kindly feedback is not likely to have a great impact of the quality of the decision making and unlikely to be appreciated in the 'strictly business' crisis environment. Aleid cautions that harsh feedback would have a negative effect. It is doubtful that this can be supported by the data, however further discussion might be appropriate later in this study, however as a rule, interpersonal communication should be firm and fair during a crisis.

Toft & Reynolds (1994) emphasise the importance of feedback and learning from exercises and incidents. They attribute a number of nuclear incidents at plants around the world to the lack of learning from previous incidents. The plants in question share common components. The Three Mile Island (TMI) reactor incident in March 1979 involved a valve failure. The same type of valve stuck at Crystal River plant in Florida on February 26th 1980, causing contained leakage of 190,000 litres of highly radioactive water. An identical valve failed at Davis-Besse plant in Ohio on June 9th 1985, but was noticed

early, limiting any damage or leaks. A similar valve also failed at the Heysham reactor in UK during the interim period. Toft & Reynolds found no evidence of sharing the knowledge of this potentially faulty valve type or learning from these incidents anywhere in the nuclear industry.

A similar chronology of failure can be mapped for the Kings Cross Fire (Fennell 1988). The table below shows fire related incidents leading up to the Kings Cross fire in 1987.

Figure 2-14 Fires in underground stations preceding the Kings Cross disaster

Station	Date	Time to extinguish
Oxford Circus	Nov. 1984	25 mins
Green Park	Jan. 1985	30 mins
Manor House	May 1985	25 mins
Holborn	Dec. 1985	30 mins +

(Fennell 1988)

Sandberg (2000) further supports the value of post-incident information dissemination by suggesting that competence is primarily defined as the meaning or conception the work takes by the worker, rather than just a set of attributes. This is supported by Bolk et al (1997) who state that gaining the true lessons and meaning from an experience is always retrospective, since any meaning to information can only be constructed through interaction related to that information. This argument suggests that in order for an emergency event to be meaningful, interaction must take place after the event. In the form of debriefing, this interaction could ensure that knowledge and learning is captured after the emergency or exercise.

This is supported by Drucker (1974: 7) who states

"...management is not just common sense. It is not just codified experience; it is, at least potentially, an organised body of knowledge"

(Drucker 1974: 7)

Drucker is effectively suggesting that experience is only useful if time is spent organising and analysing the knowledge.

In his thesis on emergency exercises, Smith (1999: 48) gathered data on the cost in man-hours of two different types of exercise undertaken by UK local authorities. His data were based on the average over several different exercises, including three major live exercises. A noteworthy point is that none of the exercises was debriefed, evaluated or measured in similar ways and so they could not be compared directly. Comparison and sharing of lessons from exercises and incidents is only possible if the data are recorded and measured in a similar manner. Any assessment framework should aim to incorporate a mechanism for facilitating this, and this issue will be addressed later in the study.

Snelling (1997: 50) analysed 83 exercise reports and found no benchmark or way of assessing the outcomes against intention. He concluded that there was

Figure 2-15 Average man-hours spent on exercises

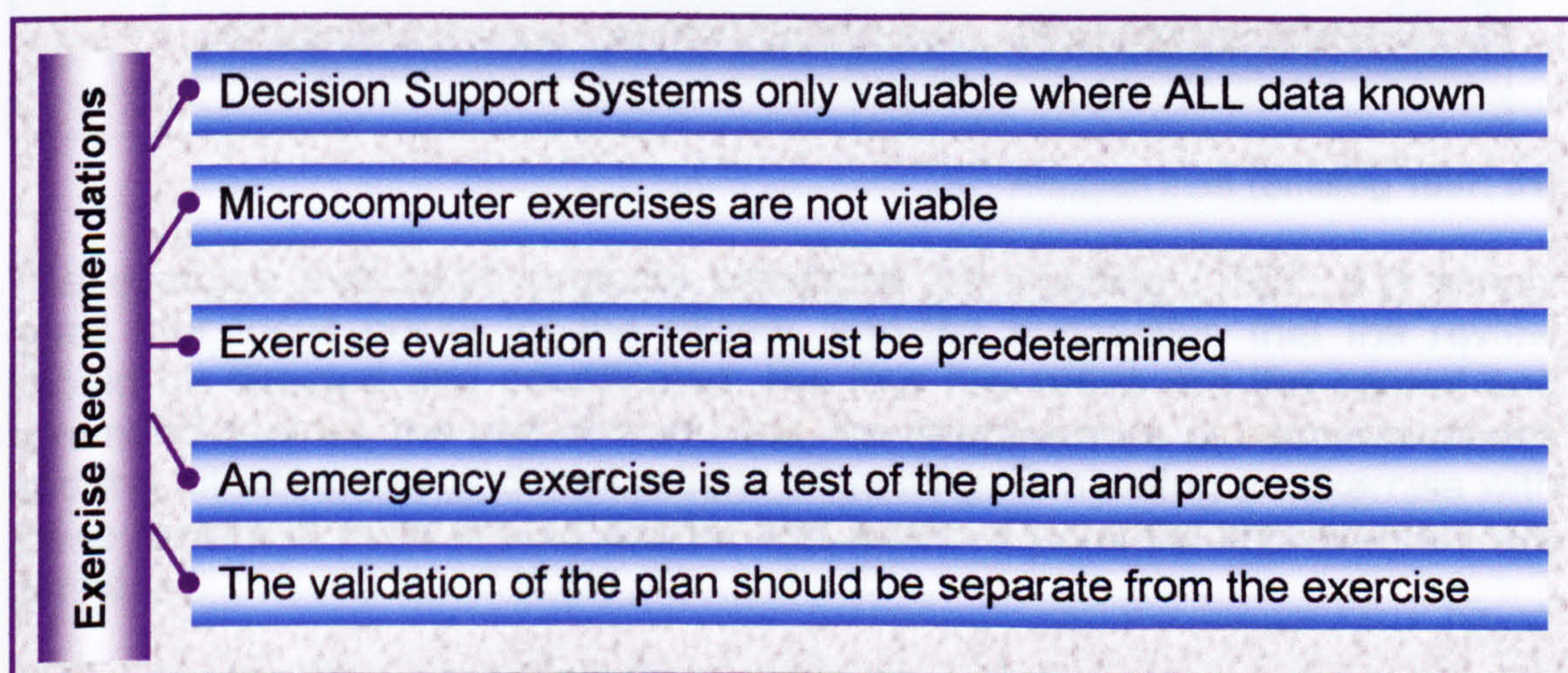
	Before	During	After	Total
Full exercise	1106	2586	387.5	4079.5
Table-top exercise	610	400.5	53.5	704

Adapted from Smith (1999: 48)

Smith's aim was to investigate the financial implications of emergency exercises, but his data are also useful in the context of this study, as it illustrates the small proportion of time spent on exercise review and learning. The results above indicate that 9% of time in live exercises is spent on post-exercise activities, and 7% of time in table-top exercise. That 9% and 7% would also include other post-exercise activities of accounting, cleaning-up and reporting. Considering the financial cost of a 4079.5 man-hour event, spending such a small proportion of the time on learning and reviewing could not give the best value for the investment.

In his research, Snelling (1997: 24) states that the evaluation of exercises has three purposes. These are proving, improving and learning. Snelling's work came up with five recommendations relating to local authority emergency exercises.

Figure 2-16 Snelling's exercise recommendations



Adapted from (Snelling 1997: 24)

His conclusion that computers do not have a role to play was appropriate at that time of writing, however advancement in the quality and reliability of computers and software since Snelling's work mean that they now have a meaningful role, at least in the provision of GIS, in LA emergency exercises. Decision support systems do require all the data on a particular issue to be known, and so their utility in more unpredictable events may be limited. The remaining three conclusions above are supported by other authors throughout this section.

Snelling (1997: 59) analysed 93 exercise reports and found no benchmark or way of assessing the outcome against intention. He concluded that there was

no tangible outcome for most exercises held by local authorities. He developed a list of exercise management protocols and evaluation measures, which he suggested would make exercises more productive and measurable.

Figure 2-17 Snelling's exercise management protocol



Adapted from (Snelling 1997: 61)

The exercise evaluation protocol presented by Snelling (1997: 61) simply gives four focus points for the review, and the suggestion that the review should be directed and coordinated. His four key areas are the control and command centres, the use of resources, the effectiveness of communications and the effectiveness and implications of training. Evaluating an exercise with these factors in mind should ensure that areas of potential improvement are defined.

Peterson and Perry (1999: 245) note that a successful exercise outcome should increase participants' perceptions that teamwork can be achieved. Peterson and Perry (1999) also state that exposing employees to experiences consistent with job demands reduces their perception of danger associated with job execution. They extrapolate this theory to suggest that realistic scenarios, if performed well, reduce the participants' perception of risk in the situation, and therefore 'form a path to stress reduction for emergency responders'. The full conclusions from Peterson and Perry's study are tabulated in Figure 2-18.

Figure 2-18 Peterson & Perry's conclusions

Perception	Hazmat Exercise	Triage Exercise
Adequate level of teamwork	Insignificant	Significant increase
Level of response network effectiveness	Insignificant	Significant increase
Adequacy of training	Significant Increase	Significant increase
Adequacy of planning	Insignificant	Not assessed
Adequacy of equipment	Significant increase	Significant increase
Level of job risk	Significant decrease	Not assessed

Adapted from (Peterson & Perry 1999: 248)

The data were compared to a 'control' team who worked for the same unit but did not attend the exercises. The control team maintained stable scores throughout.

Peterson and Perry (1999: 252) suggest that their results might be reversed if the exercise had an unsuccessful outcome, giving participants a decrease in perception of adequacy. This is untested, and can only be a guarded hypothesis from the data.

2.8.5 Simulation, IT and exercising

Smith et al. (1998) discuss 'Narratran', which stands for narrative training and was developed for the Emergency Planning College at Easingwold, UK. It is an authoring tool for multi-agency response training exercises. Their work acknowledges the problem of training for infrequent emergency events, as discussed earlier in this section. Syndicate based discussion exercises, which are very similar to table-top exercises, are suggested as one way of ensuring regular training. Through face-to-face discussion, players are exposed to each other's technical language, priorities and preferred solutions. This type of exercise also facilitates the development of a shared mental model, and helps develop the team's ability to apply certain techniques and methods to specific problems.

Smith et al. state that training exercises can be split into three stages, beginning with authoring, then delivering the exercise, and finally evaluating the exercise. They claim that Narratran is designed for the authoring stage of that process. Without examining Narratran in detail, it is difficult to say whether the designers have considered how the authoring objectives of an exercise should be similar to the evaluation objectives, and structured the tool to build exercises that can be easily evaluated.

2.8.6 Changes in UK emergency planning regulations

As this thesis is being finished, the UK emergency planning community is going through significant changes. Much of the change could be attributed as a response to the increased terrorist threat following September 11th 2001, following the lead of the USA who established the Homeland Security Directorate in 2002. Regional emergency planning in the UK will be backed up by a reserve military capability called the Civil Contingencies Reaction Force,

who can respond to a range of incidents and take on a number of armed and unarmed roles at the request of the government.

A change in terminology has also taken place, with emergency planning and civil protection being operated under the banner of 'resilience'. If resilience were being used as a concept change rather than a slogan, then the impact could be quite large, as resilience is defined as

"Resilience is the capacity to use change to better cope with the unknown; it is learning to bounce back."

(Douglas and Wildavsky 1983: 196)

And also

"...able to recover from or adjust to misfortune or change"

(Allen 2002: 753)

Reading literally, whereas emergency planning and civil protection indicated a focus on preparing for an incident, resilience suggests a concentration on activity after the incident, to return to normal. It is unlikely that a change in terminology reflects a conceptual change in terms of emergency management policy from the British Government, as there are suggestions that the new bill will be less of a radical reform than it will be a different style of structure, framework and terminology. Douglas & Wildavsky (1983) Cite CS Holling who warns that

"A system can be very resilient and still fluctuate greatly – i.e. have low stability."

(Douglas & Wildavsky 1983)

2.9 Conclusions

This short section will conclude this part of the literature review, bringing together the main points from the work that has been studied. These points will complement and direct the aims of this thesis, by identifying areas of concern and weakness in the field. Chapter 3 will identify how the objectives of the research and the weaknesses recognised in the literature can be best addressed using elements of existing models. The methodology described in Chapter 4 will then describe how the research will address these issues through the collection of new data, and through analysis.

2.9.1 Conclusions from the risk literature

The section of the review dealing with the risk literature concluded that public perception and professional assessment often come to different conclusions regarding the acceptability of risk, but both are valid and should contribute to the decision making process. There are benefits associated with risk taking, and costs connected to the presence of risk, and if that risk is realised. There is difficulty in comparing costs and benefits, when they are rarely measured in the same way and can often exist in different time-frames. The costs and benefits do not often apply to the same parties, and there is widespread inequality in where the costs of risk are borne. A number of factors, including culture, media, background, and proximity to the risk, influence a person's attitude to that risk.

It is important to ensure that groups which are vulnerable to risk are accounted for in any emergency planning efforts. Public perception of risk is also a vital consideration when planning warning and evacuation measures, and designing any measures requiring public participation.

2.9.2 Conclusions regarding emergency planning and management

The second part of the review looked at emergency planning, training and exercises. It emerged from the literature that although continuous feedback and learning are recommended throughout the emergency management field, there is very little guidance on how to carry them out in practice. Innovative approaches are required for emergency management training, because of the special skills required and the infrequent opportunities to use the training.

IT is useful in some aspects of emergency response; however, the data and knowledge required to provide useful IT decision support for live emergency situations are not yet of a standard to be widely used throughout industry and local authorities in the UK. While emergency exercises are used to test emergency plans, train staff and demonstrate competence, there are deficiencies with using an exercise-only approach to assessment, and there are limited alternative solutions. Assessing the capability of an emergency management system to meet the demands of an incident is a difficult task, and little evidence has been found in the literature of any attempts to carry out structured, detailed and improvement-focussed assessment of emergency management capability.

Toft & Reynolds (1994) define the concept of organisational learning which has been identified as an important but missing part of many emergency management systems by a number of authors reviewed in this section.

" organisational learning – cumulative, reflective and saturating process through which all personnel within organisations learn to understand and continually reinterpret the world in which they work by the means of the organisational experiences to which they are exposed."

(Toft & Reynolds 1994: 7)

They also mention the importance of learning from positive and negative events. Positive events can include consultancy input, exercises and third party experience. The negative events they refer to ones which are damaging to the organisation, usually emergencies and disasters. Near-miss events, which Toft and Reynolds do not mention, are negative in the respect that they are the beginning, or trigger of a potential emergency, but positive in the sense that they are sufficiently well controlled to prevent escalation into a full emergency.

2.9.3 Research in emergency planning and management

A number of theses have been referred to in this chapter, and in preparation for Chapter 4 which details the methodology used for this research, it is helpful to reflect on some of the conclusions of other research work and the methods used elsewhere in the field.

The aim of Steed's thesis (1998) was to generate baseline information on emergency planning in the UK. Steed used a questionnaire which was distributed to all 54 local authorities in the UK. Some 29 authorities returned a completed questionnaire. The questionnaire used by Steed was rather simplistic, seeking only yes or no answers. Where individual respondents provided written comment supporting their views, Steed provides scant analysis of this, stating

"...where individual comment appears to be relevant, reference is made to them to aid interpretation."

(Steed 1998: 90)

One of the more surprising conclusions to be drawn from Steed's work was that 80% of respondents indicated that a particular incident prompted them to prepare incident plans. This suggests that emergency plans were not created using a risk-based approach; they were instead based on a reactive premise.

The work of Peterson and Perry (1999: 252) was methodologically sound and produced some good results. Their results highlighted the difference in practice between the UK and USA, especially in terminology. Their conclusions are firm and valid for emergency responders, rather than emergency managers. However, their suggestion that their results might be reversed if the exercise had an unsuccessful outcome, giving participants a decrease in perception of adequacy is untested, and would require further investigation. Notably, they state that exercises are both an important part of emergency management and an avenue to continuous quality improvement.

Carthey (1998) studied the Nuclear Emergency Management (NEM) system at several nuclear sites in the UK. Her research focuses only on simulated nuclear emergencies involving a theoretical release of radioactive material. The sites involved held five exercises per shift per year. Exercises are the only opportunity to train for Nuclear Emergency Management in a realistic setting, as events are very rare and it is most unlikely that an event escalates as far as a release.

Carthey mentions that the problems of field research include difficulty in developing a data collection method that allowed data to be collected in a robust and consistent manner. This referred to the fact that the researcher was unable to control the exercise scenario, and the research had to balance the aims of the project against the resources available.

That study focussed on site emergency procedures, and Carthey agreed with the views expressed elsewhere in this section regarding the fortunate rarity of nuclear incidents, but the unfortunate lack of opportunity to practice nuclear emergency management skills.

The following chapter will give details of the model framework that has been adapted to assess emergency management. This will be followed in Chapter 4 by a detailed examination of the methodology chosen for this research, taking into account the research methods popularly applied in the field and discussed above.

Chapter 3

Review of capability assessment models

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3.1.1 Computer based simulation

The first methodology which could be considered is a computer-based assessment of emergency management performance. The technology exists to create a high level of reality in simulations, through the use of video, computer generated images and live information feeds. These systems are available in the commercial sector, and can provide feedback on performance in one of their scenarios. A typical system is discussed by Fin (1996) as being used at the Manroze training facility, where the control room of an offshore platform is simulated to assess the capability of the Offshore Installation Manager and his team in dealing with an emergency. The systems are however expensive and require training in order to be able to operate them and design simulations. A framework based on computer simulated performance testing would not give an overall measure of capability, and would have to be accompanied by additional assessment measures.

3.1.2 Balanced Scorecard approach

The Balanced Scorecard was used for the EMPIRE project described in section 1.1. It proved a useful basis for the risk-based performance evaluation. The Scorecard framework was however a numerical scoring approach, which depended on establishing the relative values of each indicator and scoring accordingly. The scorecard was based on an exercise assessment, including site briefing and document review. While it provided a

3 Review of capability assessment models

3.1 Basis of assessment framework

"Management has been studied systematically and scientifically since the mid-twentieth century, although remarkably few research findings have been applied to the coordination of disasters and emergencies. Indeed, throughout the world in this field of endeavour it seems to be considered normal to muddle through, managerially, rather than apply the principles of human organisation."

(Alexander 2002b: 135)

As suggested by Alexander, there has been a recognised academic interest in the study of management and human organisation for some time. The literature suggested that a model to assess emergency management should not only investigate performance, but also the wider issues of organisational capability. It was appropriate therefore to use the management field as a source of theory and inspiration on which to build the assessment framework.

The lack of learning and progress within the emergency management field has also been identified as an ongoing problem, and one which this study aims to address. Any suitable models should also take into account the need for multiple levels of stakeholder involvement in emergency management, as the risk literature identified different groups that are affected in different ways by risk.

Several approaches to capability assessment are discussed briefly here, before a detailed description of the model chosen as the basis for the framework.

3.1.1 Computer based simulation

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reasonably wide-ranging assessment, the scorecard was a wholly numerical scoring system, which provided feedback related to the scoring band in which an organisation was performing. The EMPIRE methodology also did not make a detailed assessment of the emergency plan, a recommendation made in the EMPIRE report (Strutt et al. 2001).

3.1.3 Capability Maturity Model

The Capability Maturity Model (CMM) is a framework for measuring continuous capability improvement in an organisation. The model was designed for the software industry, to specifically address the problems of the software development process. The current commercial version of the model has been developed by the Software Engineering Institute (SEI) at the Carnegie Mellon Institute, University of Pittsburgh. The model has been used as the basis for other research, mentioned in Chapter 1. The model also considers the requirements of multiple stakeholders in the assessment, and so fits the criteria defined from the literature. The following parts of this chapter present the background of the CMM, and discuss how it can be adapted to assess emergency management performance and capability.

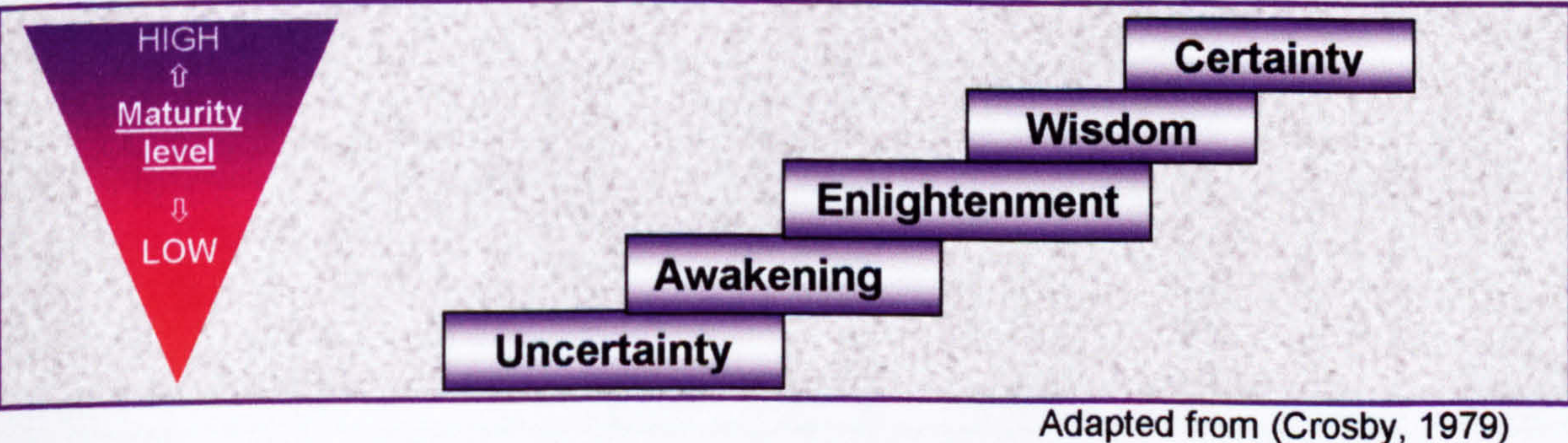
3.2 Origins of Capability Maturity Modelling

The principles of CMM originate from work on quality control in the 1930s. Control of quality using performance statistics was pioneered by Shewart, and developed further by Deming, then later by Juran (Paulk et al. 1993). The five levels of maturity at the core of CMM, are based on work carried out by Crosby in the early 1970s, which developed a five stage framework to measure and manage quality in organisations. Crosby was one of the early quality pioneers who demystified quality and made it accessible and achievable throughout organisations. Through his work at the ITT Corporation and personal study and observation, he strove to prove that quality is

“...too important to leave to the professionals... the execution of quality is the obligation and opportunity of the people who manage the operation.”
(Crosby 1979: 23)

Crosby realised that there was a need to provide a tool which could show the impact and performance related benefits of implementing quality management in an organisation, so he designed the Quality Management Maturity Grid. It allows an organisation to assess the level of implementation of its quality practices. The grid is divided into five evolutionary stages of maturity.

Figure 3-1 Crosby's Quality Management Maturity levels



Six performance indicators are also given down the columns of the grid. For every performance indicator, a statement describing typical characteristics of an organisation at each level of maturity is provided. The assessor selects the most appropriate statement to his own organisation's status. Crosby recommended that the assessment be carried out by that section's operations manager, a shop-floor worker from another section and the operation's quality manager.

Crosby suggested that for each performance indicator, a score between one and five should be given, according to the level at which the organisation was estimated to be performing. This gave a maximum achievable score of 30 for the grid. The grid can be used to compare different companies or sections within a company, and more importantly it provides an indication of the next level of improvement for that company. In 1985 however, IBM adapted Crosby's Quality Management Maturity Grid, and found use for his theory in a new context.

To summarise Crosby's contribution, there are several aspects of his work which form the basis of later CMM development. His Quality Management Maturity Grid introduced the idea of five hierarchical levels of maturity. By examining certain characteristics and processes in an organisation, its maturity can be classified. Once its status is known, the objectives for further improvement can be defined. Crosby also made clear that the improvement process is continuous, which means installing feedback and learning cycles within the normal operating structure of an organisation. He also advocates that the true aim of improvement is to prevent defects from happening, rather than appraise and repair once the defect has occurred. These three principles can be tracked throughout later development of the models, described below.

Management Categories		Level 1 Uncertainty	Level 2 Awakening	Level 3 Enlightenment	Level 4 Wisdom	Level 5 Certainty
Management understanding and attitude	No comprehension of quality as a management tool. Tend to blame quality department for 'quality problems'	Recognising that quality management may be of value but not willing to provide money or time to make it all happen	While going through quality improvement programme learn more about quality management; becoming supportive and helpful	Participating. Understand absolutes of quality management. Recognise their personal role in continuing emphasis	Consider quality management an essential part of company system	
Quality organisation status	Quality is hidden in manufacturing or engineering department. Inspection probably not part of organisation. Emphasis on appraisal and sorting	A stronger quality leader is appointed but main emphasis is still on appraisal and moving the product. Still part of manufacturing or other.	Quality department reports to top management, all appraisal is incorporated and manager has role in management of company	Quality manager is an officer of company; effective status reporting and preventative action. Involved with consumer affairs and special assignments	Quality manager is on board of directors. Prevention is main concern. Quality is a thought leader	
Problem handling	Problems are fought as they occur; no resolution; inadequate definition; lots of yelling and accusations	Teams are set up to attack major problems. Long range solutions are not solicited	Corrective action communication established. Problems are faced openly and resolved in an orderly way	Problems are identified early in their development. All functions are open to suggestion and improvement	Except in the most unusual cases, problems are prevented	
Cost of quality as % of sales	Reported: unknown Actual: 20%	Reported: 3% Actual: 18%	Reported: 8% Actual: 12%	Reported: 6.5% Actual: 8%	Reported: 2.5% Actual 2.5%	
Quality improvement actions	No organised activities. No understanding of such activities	Trying obvious 'motivational' short-range efforts	Implementation of the 14-step programme with thorough understanding and establishment of each step.	Continuing the 14-step programme and starting Make Certain	Quality improvement is a normal and continued activity	
Summation of company quality posture	'We don't know why we have problems with quality'	'Is it absolutely necessary to have problems with quality'	'Through management commitment and quality improvement we are identifying and resolving our problems'	'Defect prevention is a routine part of our operation'	'We know why we do not have problems with quality'	

Figure 3-2 Crosby's Quality Management Maturity Grid

3.2.1 Early CMM framework

Crosby's framework originally addressed the problem of implementing a new practice within an organisation. Humphrey and his colleagues at IBM saw the success of Total Quality Management and wanted to install a 'Shewart-Deming' improvement cycle (plan-do-check-act), continually to improve software development processes. Similar improvement measures had been implemented in software industry processes on many previous occasions however, without a great success. Humphrey realised that improvements were unsustainable because of culturally ingrained problems, and that an approach was required that addressed the organisation, not just its individual processes. Humphrey's breakthrough was realising that change must be implemented in stages in an organisation continuously to remove impediments to improvement. His innovative insight was that organisations had to eliminate barriers in a specific order, if they were to create the correct environment to support continuous, sustainable improvement (Curtis, Hefley & Miller 2001). Humphrey's framework was designed to guide an organisation through a series of cultural transformations, each of which supports the deployment of more mature development processes.

The improvement of the organisation was believed to be dependent on repeatability, as without that stability of structured repeatable practices, there was too much variability in the process and product. A variable environment is not a sound basis for sustainable improvement. The removal of variability created a more stable organisational structure, and ensured that CMM was not the silver bullet that many previous management fads proved to be.

The first process maturity framework was designed in the form of a maturity questionnaire in 1986, to address the problems within the software development industry. These problems were of particular concern to the U.S. Department of Defence (DoD) as they were the world's largest software customer. DoD required a methodology for the assessment of their software contractors' capability. Humphrey moved to the Software Engineering Institute (SEI) in 1986. The questionnaire evolved into the software process maturity framework over the following four years, as a result of experience in software assessments and feedback from government and commercial clients. Version 1.0 of the CMM was released in 1991, and has been developed and enhanced through several revised versions. The basis of the Software CMM (SWCMM) is detailed below.

3.2.2 Software CMM (SWCMM)

The SWCMM was designed for assessing the maturity of the software production process. The output of that process is a tangible product, the quality of which can be measured physically and quantitatively. The five-level model provides a sequence of stages for continuing improvement, and presents priority actions for improving software practice. The table below illustrates how Crosby's original three factors of continuous improvement, prevention of defects and a five-stage hierarchical structure have been continued throughout the new framework. The second maturity level also reinforces the importance of repeatability as a foundation for continuous improvement.

Figure 3-3 Maturity levels of SWCMM

Level	Key characteristics of process
5-Optimising	Continuous improvement. Double-loop learning – feedback on performance is used in refining the process. Proactively identifies strengths & weaknesses. Goal is prevention of defects
4-Managed	Quantifiable and predictable. Process is measured and operates within quantitative boundaries. Defects fed back into process for attention
3-Defined	Standard and consistent. Stable, documented & used
2-Repeatable	Disciplined. Planning & monitoring of process, and success can be repeated
1-Initial	Organisation does not provide a stable environment for process

(www.software.org 2001)

CMM places an organisation in one of the five maturity levels described above. The placement of an organisation on the above scale is achieved by assessing approximately 18 Key Process Areas (KPA's). A KPA is a cluster of related activities which must be carried out together.

Figure 3-4 Key Process Areas and maturity levels of SWCMM.

Level	Focus	Key Process Areas
5-Optimising	Continuous improvement	Process Change Management Technology Change Management Defects Prevention
4-Managed	Product & process quality	Software quality management Quantitative Process Management
3-Defined	Engineering process	Organisational process focus Organisational process definition Peer reviews Training programmes Inter-group co-ordination Software products engineering Integrated software management
2-Repeatable	Project management	Requirements Management. Software project planning Software project tracking & on-site Software subcontract Management Software QA Software configuration management.
1-Initial	Heroes	No KPA's available

(www.software.org 2001)

An organisation must exhibit all of the Key Process Area (KPA) at a particular level, in order to be graded at that maturity level. Assessors seek evidence of KPA achievement through visiting the organisation, interviewing key managers, carrying out a survey of a sample of the operational staff and reviewing the organisation's documents and procedures. From this evidence, the maturity of the organisation is evaluated, and by focussing on the KPAs which are not currently in place, capability improvement recommendations can be made.

In a survey of organisations (Paulk et al 1995) that have used SWCMM and implemented change, SEI has shown quantified improvement in the

performance of those organisations. Their analysis shows that when an organisation moves from maturity level one to level three, its ability to meet schedules improves from 32% to 80% and the perception that their product quality is good or excellent improves from 64% to 100%. The advantages to an organisation of using this process improvement methodology appear to be substantial.

The survey also shows the range of maturity levels across all of the organisations assessed, which gives some indication of the maturity of the software industry as a whole. SEI data indicate that 75% of organisations assessed with SWCMM (Paulk et al. 1995) are categorised at level 1 and 15% of organisations are placed at level 2. Level 3 is home to 8% of organisations, whose processes are defined and consistent and only 1.5% of assessed organisations reach level 4. A meagre 0.5% of organisations achieve level five, which dictates that they must be continuously improving their processes and products. The model has been applied widely throughout the software industry in the UK and USA. It has also been customised to monitor processes in the telecoms industry.

In summary, the SWCMM provides a structured assessment of an organisation or project based on its key processes, and indicates the level of maturity at which that organisation / project exists. Based on this maturity level, the implementation of further key practices can be recommended to improve the capability of the organisation. The framework is adapted easily to other applications where a process results in a physical product. The popularity of the SWCMM in the early 1990s resulted in a number of requests from the software industry for a similar tool to improve their workforce practices. The process maturity framework was designed to be applied to practices which influence performance and business objectives. Therefore it was considered an appropriate basis for a new tool, as workforce practices are critical to organisational performance.

3.3 People CMM (PCMM)

The first version of PCMM was introduced in 1995 and widely used in large manufacturing engineering organisations. The primary purpose of PCMM is to improve the capability of the workforce. The workforces are responsible for carrying out the organisation's key business activities, and therefore should have a range of knowledge, skills and process abilities at their disposal.

Workforce capability indicates an organisation's:

- Readiness to perform
- Likely results from performing business activities
- Potential for benefiting from investment in process improvement or advanced technology

(Curtis, Hefley & Miller, 2001: 4)

In a similar way to the software production process, workforce management fads have been around for a number of years, yet there have been no significant advances in workforce practice. The reason is thought to be the

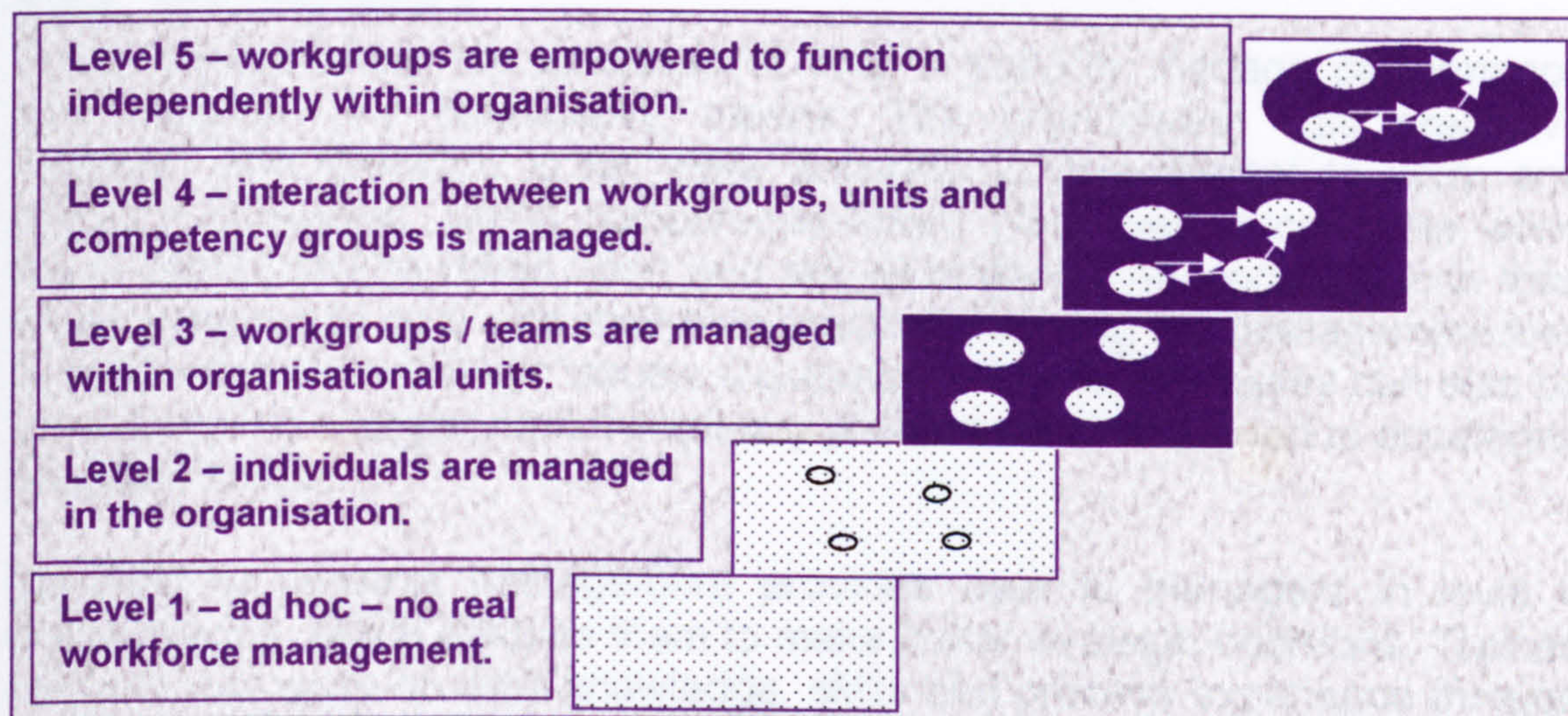
lack of management commitment, and an unintegrated approach to implementation. PCMM was designed to

“...integrate workforce practices into a system and involve management early in their deployment”

(Curtis, Hefley & Miller, 2001: 8)

PCMM has five levels of maturity, and KPAs assigned to those levels, which must be achieved before progression can occur. The diagram below illustrates the five maturity levels of PCMM, and to which aspects of the workforce they relate.

Figure 3-5 PCMM levels applied to workforce



3.3.1 Maturity level 1

The initial maturity level of the PCMM is a default stage, where all organisations who fail to meet the criteria for level two reside. Performance at this level is unmanaged and ad-hoc and any success would be the result of the problem-solving skills and performance of specific managers and individuals.

3.3.2 Maturity level 2

Level 2 indicates that an organisation is performing the basic management role, in developing and taking care of their workers. Focusing on the unit level, workers are trained to carry out their assigned tasks and compensated appropriately for their work. Their work environment is managed to ensure that any threats to health, safety or efficiency are dealt with. The aim at this level is to establish practices which address basic problems and prepare managers for the more sophisticated concepts which will be necessary to improve further. Basic communication between the organisation, unit and worker are essential foundations for progression to higher levels of maturity.

3.3.3 Maturity level 3

A level 3 organisation identifies common skills and knowledge required for carrying out business activities. It develops competencies in its workforce which help to achieve its business objectives. Each competency is made up of an integration of the knowledge, skills and process abilities. The workforce

competencies are the mainstays of the strategic business plan, and together make up the core competency of the organisation. At level 3 the workforce competencies are mapped against current and future work commitments and the practices implemented at this level are important in enabling business strategy. Once the workforce competencies are defined, other processes such as training, staffing and development practices can be focussed on developing the knowledge, skills and process abilities to achieve them. Workforce practices are also adapted to an organisation's business needs by the motivation and enabling of the workers. The development of a common organisational culture is essential at this stage. The professional workforce now shares the responsibility for achieving business objectives.

3.3.4 Maturity level 4

Organisations which are assessed at level 4 maturity manage performance and capability by quantitative means. The organisation has predictive capacity, and therefore is far more accurate in commitment to work and planning schedules. Using competence-based processes to complete work, the products can be relied upon and are consistent. The workforce can then be empowered to deal with their own practices, leaving the management free to concentrate on strategic issues. Competency-based processes can also be integrated into a larger, multidisciplinary process which is proven to accelerate business results.

Quantitative process management provides data to managers in level 4 organisations, which enables them to make better strategic decisions. Trained mentors can pass on their knowledge, skills and process experience through a structured, targeted programme to junior workers, enhancing learning throughout the competency community.

3.3.5 Maturity level 5

Organisations which reach level 5 maturity are classified as optimising. The whole organisation is focussed on continual improvement. The capability of individuals, workgroups and units, competency-based processes and workforce practices and activities, are all continuously monitored and assessed. Individuals and workgroups are empowered to control their own style of operating, and the workgroups absorb and learn from different working practices. Continual maintenance is required to ensure that performance at all levels is aligned to the organisational objectives.

Each maturity level (2-5) has between 3 and 7 process areas, known previously as KPAs in the SWCMM. A process area is

"a cluster of related practices that, when performed collectively, satisfy a set of goals that contribute to the capability gained by achieving a maturity level."

(Curtis, Hefley & Miller, 2001: 29)

PCMM focus and process areas according to maturity level are shown in Figure 3-6.

Figure 3-6 Process Areas and maturity levels of PCMM.

Level	Focus	Key Process Areas
5-optimising	Continuously improve and align personal, workgroup and organisational capability	Continuous workforce innovation Organisational performance alignment Continuous capability improvement
4-predictable	Empower and integrate workforce competencies and manage performance quantitatively	Mentoring Organisational capability Management Quantitative performance management Competency-based assets Empowered workgroups Competency integration
3-defined	Develop workforce competencies and workgroups and align with business strategies and objectives	Participatory culture Workforce development Competency-based practices Career development Workforce planning Competency analysis
2-managed	Managers take responsibility for managing and developing their people	Compensation Training and development Performance management Work environment Communication and coordination Staffing
1-initial	Workforce practices applied inconsistently	

(Curtis, Hefley & Miller, 2001)

3.3.6 Origins of workforce management principals

PCMM is not the first set of principles designed to improve workforce practices. In 1916, one of the classical management theorists Henri Fayol published his fourteen principles of management, stating clearly that they were by no means exclusive, and management should remain flexible and adaptable in order to survive (Mullins 1996). Several of Fayol's principles are similar to the PCMM process areas.

Figure 3-7 Comparison of PCMM and Fayol's principals

Fayol's principals	PCMM parallel
Division of work – better work for the same effort, advantages of specialisation	Competence-Based practices – focus on improving knowledge, skills and process abilities for each worker
Unity of direction – one plan and one head for any group of activities with same objective	Organisational performance alignment – aligning the activities of the workgroups and units to the objectives of the organisation
Subordination – interest of the organisation should dominate individual / group interests	Participatory culture – individuals involved in contributing to all levels of organisation
Remuneration – to satisfy employee and employer, reward effort	Compensation – workers should be rewarded for their efforts
Order – material order prevents material loss	Work environment – an environment conducive to effective and efficient operations
Stability of tenure of personnel – prosperous organisation should have stability for personnel	Career development – organisation should provide a tracked and developed career path for individuals
Initiative – represents a source of strength for the organisation	Continuous workforce innovation – seek and test new ideas and developments from workforce

Fayol's principles taken from (Mullins, 1996)

3.3.7 Structure of PCMM and assessment

One of the key strengths of CMM, demonstrated from Crosby's early work, is that it is a tool for continuous improvement rather than just an assessment technique. The five evolutionary levels clearly prescribe what an organisation needs to have in place before it can attempt higher level practices. PCMM is based on the same hierarchical principal. Level 3 workforce developments and workforce planning can not take place until level 2 staffing, compensation, communication and effective work environment are in place.

3.3.8 Suitability of a PCMM basis for Emergency Management Improvement

In the same way that the original model (SWCMM) addresses the software production process, PCMM looks at the maturity of the workforce, workgroups or units which make up the organisation. Rather than the quality of the software product being the ultimate concern, the competency of the workers is the focus of the PCMM.

An emergency management can be summed up as the actions of people, taken within a system to reduce loss of life and assets and limit environmental damage. The knowledge, skills and competencies of the individuals and teams are critical to the success of emergency management. For this reason, PCMM appears be a good basis for the framework to assess emergency management capability and continuous improvement.

Using PCMM as a basis would give a number of advantages over using the more technical, production-process oriented SWCMM. The PCMM model is focussed on the competency and interaction of people and teams, which is the basis of most emergency management systems in MAHI. The alignment of these teams to the goals and objectives of the organisation is vital for the success and efficiency of the response.

PCMM also enables cross-organisational benchmarking, which has great benefits in emergency management, as discussed in Chapter 2. CMM and PCMM help organisations to improve the efficiency of their processes, to improve their competitive position and increase their profits. An organisation which has effective means of increasing its profits, is likely to keep those methods to itself in the interests of competition. An organisation that has new and effective techniques for emergency management however, should find ways to share these with its peers, as the common goals of saving life, protecting the environment and safeguarding assets are shared by all organisations.

3.4 Conclusion of model selection and description

This chapter has moved the progress of the research from the problems and issues identified in Chapters 1 and 2, to inspiration for solutions identified in the literature. Chapter 3 has identified a model and theory basis for a framework assess emergency management capability. Chapter 4 will now detail the method by which that assessment framework will be constructed.

Chapter 4

Methodology used in this research

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4 Research Methodology

In Chapter 2 appropriate literature was reviewed and questions and issues to be answered by this research were identified. The research methods of other academic studies in this field were also briefly discussed. Recognising the aims and objectives stated in Chapter 1, a model framework that could be adapted to assess emergency management capability was identified in the literature. Chapter 3 presents a detailed discussion of this model, and the ways in which it can be adapted for use in this study.

This Chapter presents the research methodology. It shows how the structure of the Capability Maturity Model (CMM) has been strengthened by data collected from the emergency management field, to construct a framework to assess emergency management capability. The purpose of this chapter is to describe and justify the research methods used in this project. The chapter will describe in stages how this research was carried out, identifying the methods used and the reasons for choosing those methods. There are a number of texts on the subject of research methodology, and where appropriate these have been referenced as guidance. The diagram (Figure 4-1) summarises the methodology used in this research. The stages indicated in the diagram are described in full in the following subsections.

4.1 Background discussion and expert counsel

One of the first stages of the research methodology was to seek the expert advice of the research sponsors, OCTO Ltd. The organisation has a track-record of providing specialist emergency and crisis management training to industry and government agencies throughout the UK. They drew on their current and detailed knowledge of the field to identify some of the important issues which should be addressed in the research, and provided guidance on how these might be investigated in the field. They sought advice and collaboration from their clients and contacts throughout MAHI and the regulators, and provided advice, briefing and guidance throughout the project.

The research supervisor also drew from an extensive background in designing and building assessment models for industrial application, and provided detailed academic guidance on acceptable methods and research techniques. The supervisor also used his network of industrial and academic contacts to establish the requirements of emergency management capability, and it was from this combined expert advice, along with the issues identified in the literature, that the research methodology stemmed.

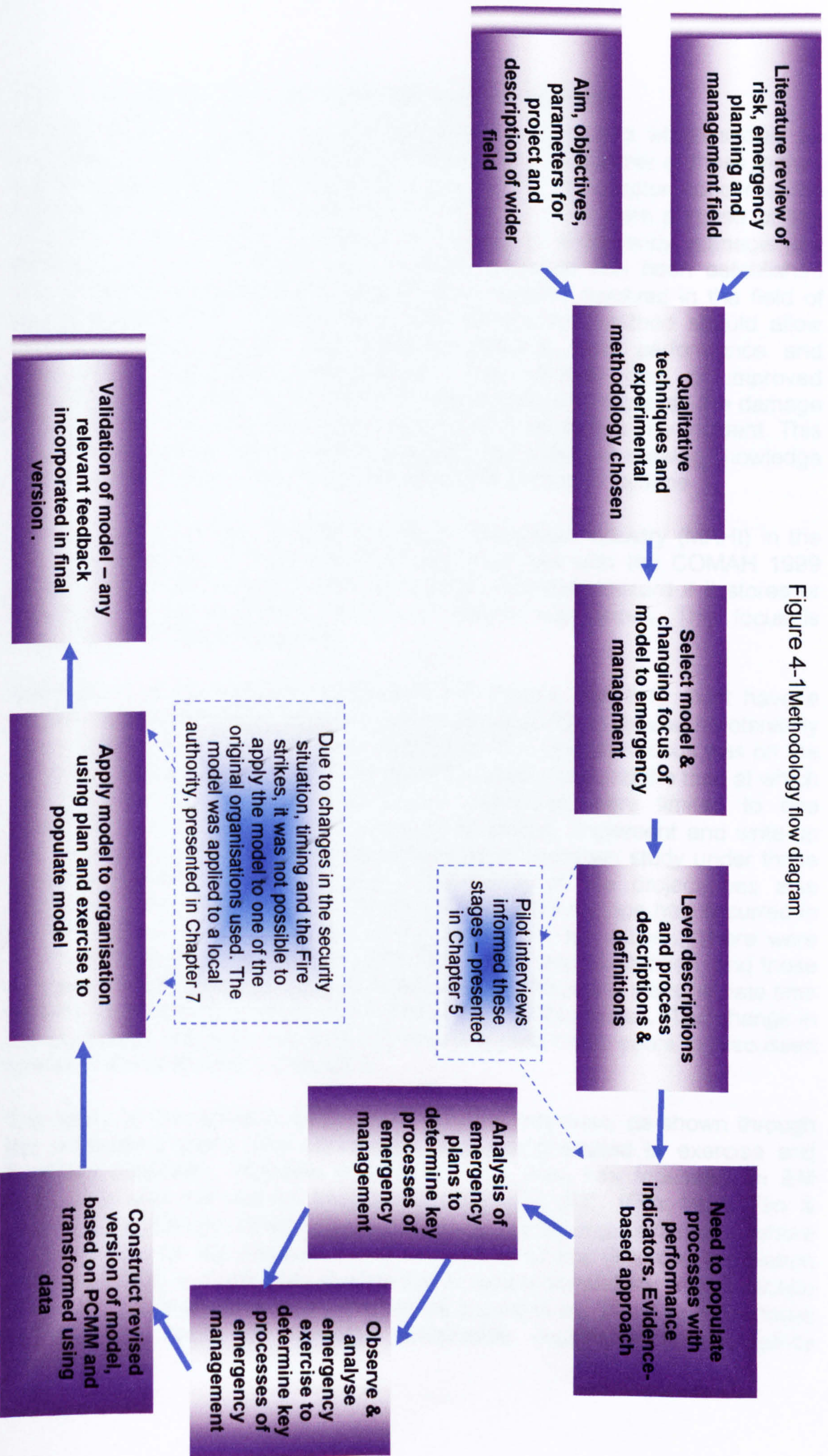


Figure 4-1 Methodology flow diagram

4.2 Purpose, focus of study and units of analysis

Patton (1990: 197) gives a comprehensive list of factors which should be considered when designing research methodology. A number of those factors will be addressed in the following subsections. The factor concerns the purpose of the study. As presented in chapter 1, the core purpose of this research is to provide a method of assessing emergency management performance and capability. This research question has been established from industrial, academic and governmental experts involved in the field of Industrial emergency management. The assessment method should allow organisations to assess and ultimately improve their performance and capability in emergency management. The ultimate goal of improved capability is to increase the number of lives saved, and decrease the damage to the environment and assets that can occur in an emergency incident. This classifies the research as 'applied research', because it is seeking knowledge which can be used to improve the effectiveness of human actions.

The focus of the study is Major Accident Hazardous Industry (MAHI) in the UK. The definition of hazardous industry is in line with the COMAH 1999 regulations, which classify a site as a Major Accident Hazard if it stores or processes above a certain amount of certain substances. This focus is appropriate for several reasons.

The nature of the hazards faced by MAHI means that they must have a tangible and significant emergency response capability to deal with potentially high consequence, rapid escalation incidents. The research focus was on the UK rather than European MAHI due to limited resources and the time at which the research commenced. The project resources were limited to one researcher and the period of three years to design, implement and write-up the research project. To carry out a meaningful European study under those constraints would not be feasible. The timing of the project was also significant. When the project began in 1999, a major change had occurred in the UK statute, bringing the MAHI in line with EU regulations. There were member states that were ahead of the UK in their implementation, and those who were lagging behind. It would have been a difficult and inappropriate time to carry out meaningful comparison across the member states. The change in the European research environment over the past three years is discussed further in the Discussion, Chapter 8.

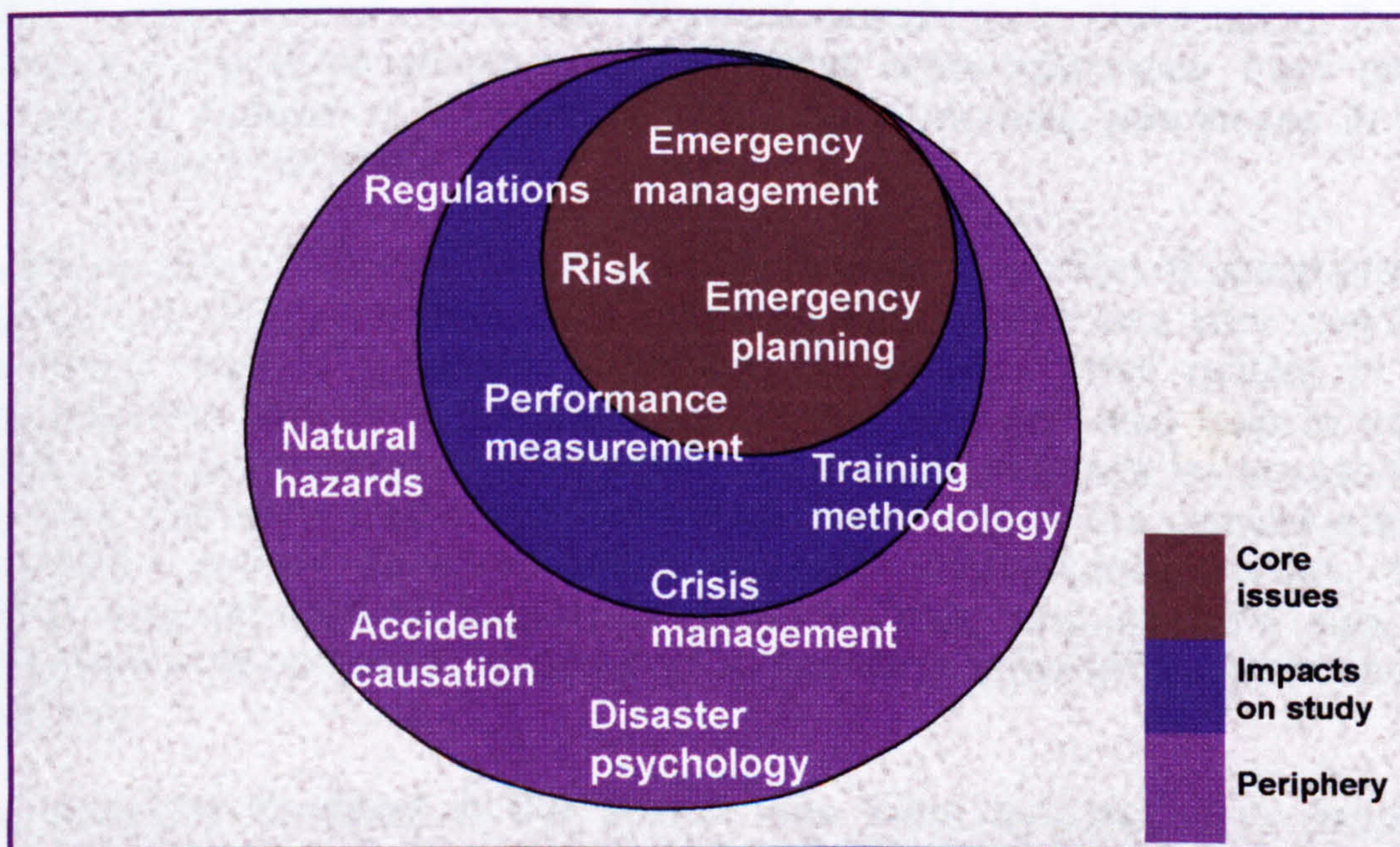
The focus of the research is the organisational response, as shown through the emergency plans and procedures, and demonstrated in exercise and feedback capability. Previous research in this area has focussed on EM leadership and the role of Emergency Controller (EC) (Flin 1996; Flin & Slaven 1996; Skriver 1998). This focus was especially appropriate to offshore emergencies, as the behaviour and leadership of the Offshore Installation Manager (OIM) is of principal importance in rapidly escalating, limited escape scenarios. EC leadership focus was not as crucial to the MAHI situation focus on the EC does not consider sustainable organisational emergency management.

This study is therefore defining the organisation as the main unit of analysis, as the research is looking at organisational performance and capability. The EMT plays a central role in that capability, and so the Emergency Management Team (EMT) is therefore the unit of analysis for the emergency exercise observations. The emergency plan is focussed on the entire organisational response, so the unit of analysis for that part of the data collection is the whole organisation.

4.3 Literature review methodology

The aims of the literature review were to discover the scope of previous work and identify how established knowledge could contribute to this research. It also aimed to build an appreciation of the concepts and theories involved and show how previous work supports this study. The literature review process began by defining the boundaries of the search. It was important to ensure that the review does not sprawl to cover issues which are unconnected to the subject, and also to provide rigorous assurance that all related material was drawn together. This was aided by drawing a concentric circles diagram, as shown in Figure 4-2.

Figure 4-2 Literature review focus diagram



The central area is the core subject, upon which the thesis is based. The review should thoroughly explore issues within this circle. The blue circle contains the issues which impact on the study, but are not central to the thesis. They should therefore be reviewed in some depth, and preferably linked to some of the core matters. The purple outer circle contains peripheral issues, which impact on the thesis but do not warrant discussion in their own right. It is important to demonstrate knowledge of the issues in all circles, but the depth of that knowledge should be relative to the proximity to the core subject. Some subjects span more than one circle, as they have some aspects which impact on both spheres.

Once the literature subjects had been prioritised, several methods were used to search for and review the appropriate work. Research on the subject of emergency management has only been recently established at Cranfield campus, and so there were limited library resources available. It was necessary to seek resources in other libraries, and research was carried out at Cranfield's Shrivenham campus library, which houses a large disaster management collection. Coventry University library also has an established disaster management information and resource centre, as does the Emergency Planning College at Easingwold. Research was undertaken at both of these facilities, supplemented by visits to the British Library in London, and the Fire Service College Library at Moreton-in-the-Marsh.

4.3.1 Search methods

Searches for relevant books and journal papers were carried out physically and electronically. Electronic searches used databases of journal titles and articles which are stored on-line and could be accessed using services such as Science Direct and Pro-quest. Other databases contained abstracts and titles of papers which could be ordered in print form from the British Library. A new electronic service called 'Contents direct' was used, which involves the automatic emailing of selected journals' contents pages to the researcher when a new issue is published. Physical searching involved using library catalogues, personal recommendations and cross-references from other sources, in addition to browsing, to find books, journals and theses in the libraries mentioned above.

A service called 'Index of Theses' contains a large proportion of postgraduate theses from UK Universities, with abstracts. This service was very useful in identifying relevant research. Searching the internet often results in an overwhelming amount of irrelevant information, but can also help to trace authors, university projects and overseas literature. It should be stressed at this point that while best efforts have been made to seek out relevant similar research overseas by investigating reputable international journals, this search was confined to English language journals, and so there may be connected work carried out in non-English speaking areas which has not been identified.

The literature identified in the search was then reviewed. This process involved critique of the evidence, clarity, plausibility, use and value of the work, in the context of its relevance to this study. The review concluded with a summary of the research methods used in other studies. This summary has been used to inform the choice of research methods, described in the following sub-section.

4.4 Qualitative research method

Several factors were considered when identifying a suitable research method. The research studies reviewed in Chapter 2 provided a useful insight into established and proven research methods. An example is the quantitative approach to emergency management performance used successfully by Lyons (2002). The subject of her work was related to task performance timing, and so clearly demanded a quantitative approach.

The constraints of the field were also taken into account. Emergency management is often a secondary activity for many industries, and as such operates under tight budgetary controls. Exercises are usually only conducted for regulatory demonstrations or for training, and Carthey (1998) and Lyons (2002) both allude to their lack of input as researchers, on the design of the exercise scenarios that had been structured to demonstrate a predefined objective to the regulator. The technique of exercise observation was used by Lyons (2002) and Carthey (1998) in slightly different ways and produced valuable results in their work. It was thoroughly recommended as a worthwhile method by both authors.

Several literature sources had reviewed emergency documentation as part of their work. This included an emergency plan review by NAO (2002), emergency exercise report review by Snelling (1997) and a review of public inquiry reports by Toft and Reynolds (1994) and Haji Brahim (2000). The authors listed above have used qualitative and quantitative analysis on their data sets, however the former appears to offer greater flexibility, and is more compatible with the aims of 'applied research' discussed in 4.2. With this flexibility the applied research can respond to trends and new concepts in the data, which increase the value of the study as a problem-solving device.

Patton (1990) describes the three main qualitative research methods;

- Direct observation of subjects, or observation via video
- Written documents - work with words and visual data, not numbers
- Detailed, open-ended interviews - not highly structured

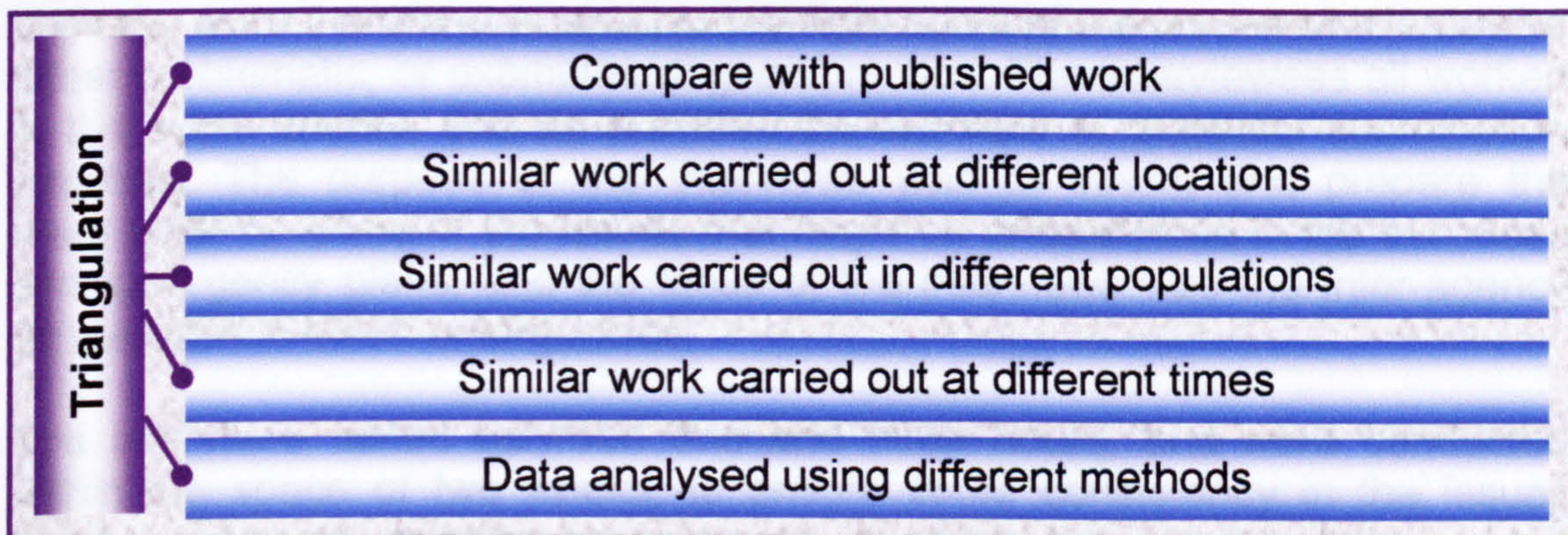
(Patton 1990: 10)

The choice of methodology for this study was based on the previous research, review of literature and discussion of the limiting factors above. A qualitative research method, involving analysis of emergency planning documentation and direct observation of emergency exercises supported by interviews with emergency management personnel was chosen as a robust and suitable combination of techniques.

This study aims to produce an assessment framework, the conclusions of which will be much stronger if it uses evidence from three sources rather than the current uni-directional assessment approach. The technique of using more than one information source to investigate the same issue is known as triangulation, and is used to improve the validity of the findings, by showing that a similar conclusion can be drawn from more than one source.

Patton (1990: 187) gives several different methods of triangulation which can be used to increase the validity of research findings (Figure 4-3). This study uses all of these methods of triangulation, apart from comparing the data to published work, as currently no appropriate comparison work is available.

Figure 4-3 Methods of triangulation



Adapted from (Patton 1990: 187)

4.5 Model adaptation

This subsection will now explain the process used to convert a model from the management field into an assessment framework for use in the emergency management field.

The first step of the methodology is to decide which aspects of the original model should be preserved and which parts need to be replaced with the appropriate detail from the emergency management field. The core of the model was its process-based maturity approach, based on continuous, evolutionary improvement, through five defined levels of capability. That important core structure of the model remains the same.

As discussed later in this study, the CMM is made up of 5 levels, each of which has a number of KPAs. The names and the meaning of the levels may need to be adapted to fit emergency management language. Some processes might still be relevant, some will need to be altered slightly and some are no longer relevant, and therefore have to be deleted. First, the data from emergency plans and exercises will be examined to see which of the original PCMM processes (if any) are present, and whether any of the existing processes, or the core intention of that process can be adapted for use in emergency management. The final process set is expected to comprise of new processes and ones which have been adapted from or influenced by the original model.

The following subsections will describe in detail how the qualitative methods of emergency plan analysis, exercise observation and key personnel interviewing were used to obtain data to inform the modelling process.

4.6 Pilot interviews

Inter-agency cooperation in MAHI emergencies is very important. The capability of an organisation to collaborate and coordinate with outside agencies, including the local authorities and external emergency services, is key to successful resolution of any incident with potential off-site consequences. It is not possible to fully observe all parties and interactions during an emergency exercise, or fully appreciate the quality and practicality

of relationships stated in emergency plans. Three pilot interviews with representatives from one fire brigade, one police service police and a local authority were therefore required to highlight some of the issues which may be either problematic, or examples of good practice. The interviewees all worked in the same county, and so provided an overview of a typical coordination structure. The purpose of the interviews was to inform and prepare the researcher for some of the issues that might be encountered in the exercises and emergency plans, and the focus of the interviews was the inter-agency cooperation in MAHI emergencies.

The interviews lasted between one and three hours, and were conducted within the space of two weeks, to ensure some consistency in the issues being discussed and the environment in which the representatives were working. These interviews were semi-structured, with discussion based around a number of important issues. As an information gathering exercise, later interviews built on and questioned issues raised by previous interviewees. The notes from these interviews are included in the appendix of the thesis (10.3), and the results are presented and analysed at the beginning of Chapter 5. The remainder of this chapter describes the process of collecting data to build the assessment framework.

4.7 Sampling strategy and security

The sampling strategy for this study was influenced by several factors. MAHI in the UK includes a range of different sectors from pharmaceutical to petro-chemical and from nuclear to chloro-chemical plants. In order to ensure that the assessment framework was appropriate across the sectors, it was necessary to include a range of different sites in the sample.

MAHI sites are classified according to the volume of hazardous chemicals on the site, rather than the site population or complexity of the surrounding area. It was therefore necessary to sample a range of sites, which included large and small site populations, sites which were in areas of dense industry and sites which stood alone in isolated areas. In areas of dense industrial activity or dense local population one might expect a demonstration of higher capability in emergency management than in an area with little outside the plant boundary.

The sample was also limited to organisations within which the research had established a contact. Some of the organisations also approached the research sponsor with the intention of taking part in this study. The reason for this limitation was the difficulty and time taken to secure permission, visits and information from organisations without prior contact. The level of detail provided to this study by those organisations could potentially have highlighted problems in their systems or plans which could have put lives at stake, or threatened environmental or asset damage. This type of information is not treated lightly, and so the assurance of confidentiality and trust provided by the researcher and the research sponsor was invaluable in securing sample organisations.

To maintain confidentiality in the transcripts of exercises, all references to particular chemicals, plant, locations and members of staff were removed or changed. The site names have been replaced with a code which allows the researcher to identify them, but does not represent the actual name or location in any way. The times of year at which the exercises took place are not released, as this could also be used to identify the organisation. Until the introduction of the COMAH regulations which began in 1999 (Health and Safety Executive 1999), many sites had their own particular terminology for Emergency Controller (EC) and Emergency Control Centre (ECC) and other emergency management components. These were replaced with standard terminology, as was any reference to specialist off-site detection vehicles which are used at a number of sites to identify gas, radioactive or environmental contamination.

4.7.1 Ethical considerations in research

There are ethical considerations in any research which involves human participants, or impacts on society in any way. The University has strict procedures to examine and authorise experimental practice, ensuring that it is carried out to the highest ethical standards.

If the emergency exercises had been designed and coordinated by the researcher, then there would have been an obligation to have the experimental method approved by the ethics committee. In this case however, the researcher was an observer in emergency exercises which had been written, coordinated and executed by a private organisation, over which the researcher had no control. The researcher was happy to report in all cases that the organisations maintained high standards of ethical behaviour in emergency exercises. Examples of this include monitoring staff for signs of stress, providing refreshment, hygiene and rest facilities for the staff during the exercise, and ensuring that the staff was not exposed to undue levels of discomfort, distress or exertion during the exercise. In the majority of cases the staff was provided with a supportive environment in which they could offer comments in a debriefing situation. Debriefing in exercises is not only important for learning, as discussed in Chapter 2, but also as a means for staff to mentally justify the events, and express their feelings and concerns.

There was an ethical responsibility on the researcher to ensure that his presence in the exercise did not add unnecessary additional pressure or stress on the participants. To achieve this aim, the researcher was introduced as 'a university student' to all the participants before the exercise began, and it was stated that the work was confidential, specific participant actions would not be shared with the management and any published results would be anonymous. The impartial image of academia reassured participants that the researcher's presence was not threatening, and there was no hostility experienced in any of the exercises. Further impacts of observation are discussed in the next subsection which examines the research method of emergency exercise observation

4.8 Emergency plan analysis

The first type of data analysis involved a sample of emergency plans. An exercise can be described as a glimpse of the reality of an organisation's emergency response, whereas the emergency plan (EP) is their statement of intent, in terms of how they would respond to an incident. The purpose and structure of the EP has been fully discussed in Chapter 2. An organisation's EP indicates the depth of understanding of the hazards and risks that face them, and their actions to prepare for and mitigate these risks. It is therefore important that any assessment of an organisation's capability involves their EP. Issues of confidentiality discussed in relation to emergency exercises above, were also encountered in relation to EPs. The selection of EPs for this research is discussed in the following subsection.

4.8.1 Sample selection

There were several objectives and limitations to be considered when selecting suitable EPs. Firstly, the organisations who were keen to be involved in the emergency exercise observation aspect of the research, were almost all still preparing their COMAH EP when this research was taking place. No site had its COMAH plan complete and checked for compliance by the Competent Authority at the time when the research was ready to collect and analyse plans. This presented a challenge to the research; however a positive outcome was achieved. In the absence of site EPs an alternative sample of plans was required, to show that evidence of emergency management capability could be found in EPs and incorporate that evidence into the framework.

Through contacts made in the pilot interviews, it became apparent that there was a wide selection of Local Authority off-site and County Emergency Plans available. These included plans which related to incidents on COMAH sites and other hazards which could affect the population. One of the advantages of using these plans was that they would give the framework a broader base than just COMAH sites. Local Authority Emergency planners are commonly employed full time to carry out EP related activities, and so the plans represent years of experience design and plan construction. With this in mind, the EPs should give a good indication of what indicators of capability should be present, and some examples of good or best practice.

Plans were available by requesting them directly from the Local Authority officers, viewing a large collection at the Emergency Planning College library and requesting copies from contacts met through professional societies and pilot interviews. England and Scotland were represented, as were a number of different hazards. The sample included Authorities of different sizes, as well as a number of plans from the hazardous site/pipeline operators. The full sample is discussed in Chapter 5, Data Analysis.

4.8.2 Analytical approach – content analysis

There were limited examples in the literature of methods of analysis for emergency plans. NAO (2000) used a simple checklist which produced a score based on the plan's content. The Literature Review (Chapter 2) identified some common weaknesses in organisational EM capability, and the

aim of this research is to build a framework of assessment that can identify those weak points, and highlight the strengths in an organisation's emergency management.

The analysis of emergency plans will distinguish the parts of the plan that indicate an organisation's strengths or weaknesses in certain key areas. The three areas identified in the literature as being important to the success of emergency management are a risk basis for the EM system, a continuous learning approach and an integrated attitude to EM. The content and style of the selected emergency plans will be analysed for evidence of these three areas of importance. This analysis will take the form of a short description of each plan, followed by a table comparing the contents of the plans to the checklist developed by the NAO (2002), and to the processes found in the PCMM.

4.8.3 Validity and confidence

Validity in qualitative research is dependent on the skill and rigour of the researcher, as they represent the 'tool' used in the fieldwork. Whereas quantitative research can sometimes boast much more consistent validity, due to the standardised, calibrated nature of the tool, it lacks the flexibility and responsive capabilities of qualitative research. The qualitative researcher learns with each experience, and can build on his or her knowledge and ability throughout the study.

The validity of the findings in this particular part of the study is strengthened by the multiple data sources. Emergency plans and exercises from different sizes and types of organisation from a range of industrial sectors and local authorities in different parts of the UK are analysed. Data on emergency management capability were analysed from emergency exercises and from emergency plans, using different analysis methods. The aim is to construct a comprehensive and robust assessment framework, and its validity is dependent on the analysis of a range of emergency management practices throughout the UK.

4.9 Exercise observation –gaining entry & training

Armado: How hast thou purchased this experience?

Moth: By my penny of observation.

(Shakespeare, 1593)

Previous research has used emergency exercise observation as a means of collecting data on emergency management performance. Carthey (1998) used nuclear emergency simulations to investigate emergency decision making, and Lyons (2002) used a range of emergency exercises to develop and support the use of a quantitative model of task performance. The research technique of observation has some minor experimental difficulties associated with it and these are further described in the Discussion, Chapter 8.

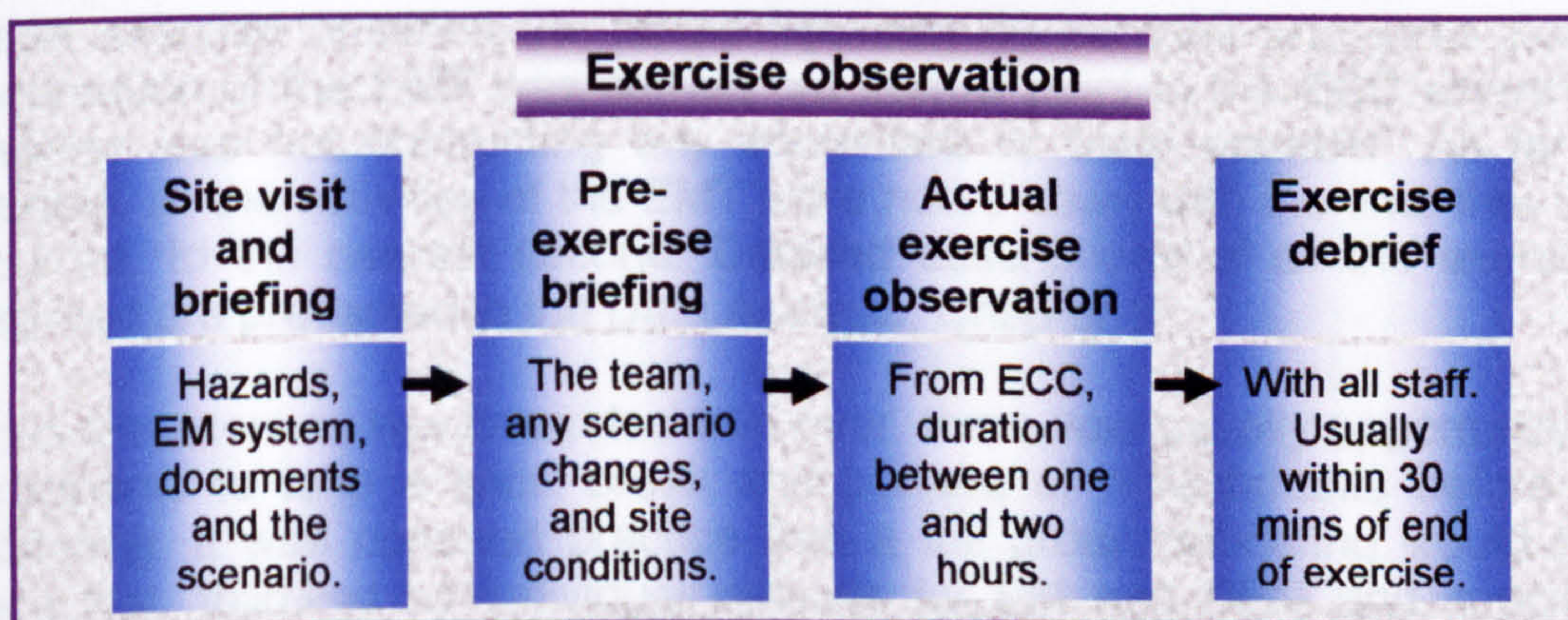
To facilitate a good research observation, it is very important to gain the trust of the group being observed. There are several recognised means of achieving this, discussed by Patton (1990: 253). The first model Patton cites from Jorgensen (1989) is known as the 'phased entrée' tactic. This involves the researcher working with another group within the organisation until they become known and trusted, then switch over to observe the group of concern. The method is inappropriate for this study, as emergency management is usually a small, stand-alone team within the organisation, and phased entrée would not be practical.

Patton (1990) states that the best method to introduce a researcher to the participants is the 'known sponsor approach'. The known sponsor approach enables a new observer to use the legitimacy and credibility of a person who is known to the participants, and held in high regard. The research sponsor had an established reputation with most of the organisations involved, so in all cases their senior consultant was the 'known sponsor' and introduced the researcher to the participants. This worked well, and further discussion of the observations carried out can be found in Chapter 8, the Discussion.

Exercise observation is a skill which must be obtained by training and guidance. Prior to this study, the researcher had been an external observer at several exercises, and a participant in a number of other exercises. This previous exposure proved useful. Further guidance was provided by the research sponsor's consultants, who have extensive practical expertise in this area. This practical guidance and advice was supported by studying a Masters level academic module in Research Methods, administered by the Human Factors Group at Cranfield University.

The process of each exercise observation at a site took between one and two days. The stages of the observation are illustrated below, and summarised in the following paragraphs.

Figure 4-4 Exercise observation stages



Before each exercise, between half a day and a full day was spent at the site. This time was usually spent with the organisations Safety, Health and Environmental department, who usually hold the remit for emergency planning and management. On larger sites there was a dedicated emergency planning department. The purpose of the visit was to become familiar with the particular

processes, operations and terminology on that site. The visit usually began with a health and safety briefing undertaken by all visitors to the site, and the issuing of Personal Protective Equipment (PPE). The depth of this safety briefing varied between sites, ranging from being asked to read the fire alarm notice and signing to say you had done so, to a short video on site safety and test questions. On sites where there can be three different alarms, each with different meanings, such a briefing is very important.

The visit would also include a site tour to familiarise the researcher with the surroundings, buildings and physical layout of the exercise scenario. The details of the scenario would then be discussed. This process was of great importance as without the background detail, much of the emergency exercise would be meaningless to the observer. As the observer had no control over the content or coordination of the simulation, this was also an important opportunity to note down procedures and assumptions that were particular to the site, which would be useful in explaining behaviour during the exercise.

The pre-exercise briefing was normally held an hour before the scheduled start of the exercise, and was for observers and the exercise administration team, which usually included telephone operators, message loggers and marshals. The briefing aimed to present the scenario as it would be delivered, and any extra detail which was being simulated or assumed. Some scenarios told the exercise players that the weather conditions were 'as reality'. Another scenario asked players to imagine that it was a windy day with temperatures below freezing. Similarly, some scenarios were set at a different time of day than reality. One exercise began at 09:00 and the players were told that the scenario time was 15:30, and daylight was fading. The level of realism in exercises will be discussed in depth later in the thesis. This pre-exercise briefing ended with the observers being taken to the ECC, and made aware of which members of staff would be playing different roles in the exercise. Once the exercise management personnel were in place, the signal was given for the exercise to be started.

Actual exercise observations lasted between 40 minutes and three hours. Observation of the EMT was carried out from a point in the ECC where the observer was not obstructing any equipment or team member. As far as possible, all the activities of the EMT were noted down with the time that they occurred, to the nearest second. Detailed descriptions of all the exercises observed are presented in the Data Analysis, Chapter 5.

When the exercise has been declared over, there was usually opportunity for participants to take a short break and partake of refreshments before the debriefing. It was common practice that a full group debriefing would take place first, followed by individual debriefs for EM and DEM and specialist teams. This stage of the exercise was usually conducted in the ECC with staff bringing extra chairs around a central table, or in a separate conference room where refreshments had been provided. Commonly the exercise coordinator would act as facilitator, and a logger would take notes of what was said. The EM and DEM usually began the proceedings by giving their comments on the exercise, and the quality and depth of the debriefing varied between sites. It

lasted typically between 30 minutes and 90 minutes. In most cases the observers were asked their comments, and these were usually a diplomatic balance of congratulating good practice and giving suggestions for improvement. If serious flaws were seen in the exercise, this was more appropriately dealt with in discussion with the senior staff at a later opportunity, rather than criticising individuals in front of the group.

During the debrief, the observer continued to take notes of all comments, but without timing, as this aspect was no longer important. In some cases regulatory debriefs were also conducted, and the observers were usually asked to leave at the request of the regulator. This was more common at nuclear sites than any other sector, but was not considered a hindrance to the research as the main debrief was usually conducted well on these sites.

The information gathered on the site and in the exercise was then transcribed into a standard format. Information which was crucial to the understanding of the exercise was written as an introduction. This was followed by a chronological transcript of the exercise events. The document concluded with the participants' debriefing comments and any additional notes from the observer. The exercise transcripts are contained in the Appendix of this thesis, and the analysis of the exercises is contained in Chapter 5.

The aim of the exercise data analysis was to determine the key processes that make up an emergency management system. The key processes that make up an organisational HR system are well known and used in the PCMM. As they are part of a model which is respected for its accuracy and comprehensive nature, it was considered astute to analyse the exercise data with these processes in mind, using them as a foundation set which can be added to, changed and deleted from according to the findings from the data. The analysis of this data began with a technique known as 'coding'. This involved analysing each exercise transcript, and highlighting evidence of any of the CMM processes. This was a useful technique, as it showed which processes were common in emergency management, and which were uncommon or present in a different format. This analysis provided a table showing the processes observed at each site, and the evidence that was provided.

4.10 Audit of Local Authority Emergency planning department

As described in Figure 4-1, the original intention of the research was to apply the completed assessment model to an organisation in a 'test audit'. The circumstances stated in the flow diagram and discussed in Chapter 8 caused difficulty in achieving this objective within the timescale of the research. The alternative was to test out the framework in another sector. Several local authorities were planning emergency exercises within the period of the research, and local authority 'A' (LAA) stood out because of the scale of the planned exercise, and the enthusiasm of the Authority to participate in the research. As enthusiasm to participate and improve is one of the factors stated as being important to the success of the assessment framework, (Curtis et al. 2001) the researcher decided to apply the framework to this

authority, using the major exercise and their newly completed emergency plan as the main focus of the assessment.

LAA requested that their details, the date and specific details of the exercise be removed from the transcript. Several different agencies participated in the exercise, which took place over a number of days.

4.10.1 Emergency exercise

The researcher attended a briefing with LAA one week before the exercise took place, and received basic details of the scenario. Observation was to take place from the Local Authority Silver command centre. A security pass was arranged for the researcher, and permission was granted by the Chief Executive of LAA for the observation to take place. The researcher attended the exercise between 07:00 and 19:00 on the first day, and attended the review and remediation discussions day from 10:00 till 16:30 later in the week. A considerable number of data were gathered, and they were transcribed into a report for LAA.

4.10.2 Emergency Plan review

The full 'emergency procedures' document from this Authority was reviewed, and evidence of the practices and processes taking place was sought. Combined with the evidence from the emergency exercise, these data would give an indication of the maturity level at which the organisation was performing.

4.10.3 Interview with key staff

The evidence from the exercise and plan were compared to the assessment framework, and there were certain practices which had been weakly demonstrated. Without further evidence of these practices, the processes would not be confirmed, and so the Authority would be placed at a lower maturity level than its performance suggested. As this was the first audit using the assessment framework, it was also important to check that there was nothing missing from the framework, and the process could be explained and justified. For these reasons, the researcher decided to carry out an unstructured interview with the emergency planning staff responsible for the exercise and for writing the plan.

The purpose of the interview was to clarify several processes and to ensure that aspects of the framework which originated from commercial hazardous industry translated into the public sector environment. The interview was carried out with the County Emergency Planning Officer, local emergency planning officer and the officer responsible for the exercise planning. It was carried out at the Authority's premises, and details of the subjects to be discussed were provided to the authority in advance of the meeting. The interview lasted one hour, and notes were written by the researcher throughout. The details of the audit, findings regarding the authority and conclusions for the model will be presented in the Results, Chapter 6.

4.11 Expert validation review

As mentioned above, extensive testing of the framework in an organisational setting was not possible within the research time-span. In order to ensure that the research product fulfilled the objectives set, was appropriate as an industrial assessment tool and was a valid contribution to knowledge, an alternative test was organised.

A group of experts from the field were invited to Cranfield for a day-long seminar. The research would be presented to this expert group in the morning, and in the afternoon there would be a discussion and opportunity for structured feedback. The group were chosen for their expertise and experience in the field of emergency management, emergency planning and qualitative research. The experts who were invited to the seminar were

Figure 4-5 Expert validation panel's credentials.

Expert	Affiliation
Professor Ian Davis	Former Chair, Cranfield Disaster Management Centre
Professor John Sharp	Visiting professor, Offshore & safety, Cranfield University
Dr Mark Lemon	Lecturer, Ecotechnology research Centre, Cranfield.
Jeremy Larken	Director, OCTO emergency management consultants
Helen Shannon	Director, OCTO emergency management consultants
Les Moseley	Director, Coventry University Disaster Management Centre
Ed Terry	Senior Consultant, Risk and Reliability and Offshore & safety.

The expert validation was a very successful experience. The full programme for the day and outcome from the discussion, with a breakdown of the critique and feedback are discussed in Chapter 7, Application of the framework.

4.12 Conclusions of the research methodology

The methodology has described how data was collected and used to construct a framework for the assessment of emergency management performance and capability. It then describes how that framework was tested within a local authority emergency planning department. The final presentation of the framework to an expert panel is then described.

The following chapter will present the data analysis, carried out in accordance with the methods described in this chapter. The data analysis will be in three sections; firstly, the notes from the Pilot Interviews will be presented, followed by the content analysis of the sample of emergency plans, and finishing with analysis of the observation data from the emergency exercises.

Chapter 5

Analysis of the data

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5 Data Analysis

The literature reviewed in Chapter 2 identified a need for a people-centred approach to emergency management assessment, and Chapter 3 discussed the merits of the CMM continuous improvement methodology. Chapter 4 outlined a method by which a new emergency management methodology could be built using the CMM framework as a basis and populating it with qualitative data from field investigations.

5.1 Structure of this chapter

A central concept of CMM is that an organisation's activities can be defined in a set of core processes. If the organisation is capable of carrying out its core processes to a high standard, then the desired 'product' or output will also be to a consistent high standard. Assessment therefore provides a targeted approach to improvement, by focussing on the processes in the system identified as being weak. The primary aim of the Data Analysis Chapter is to identify the set of processes that make up an emergency management system, and how the presence of these processes and the level to which they are performed can be assessed through in an organisational context .

Knowledge of the CMM structure and experience from collecting the data for this study has contributed to three hypotheses being suggested at this stage. These hypotheses aim to focus the analysis on several important considerations for building the assessment framework in Chapter 6. The outcomes of the hypotheses will be discussed at the end of the chapter.

Figure 5-1Data analysis hypotheses

Hypothesis	Explanation
Fewer key processes than PCMM	Emergency management activities form a small but vital part of an organisation's overall business. The PCMM has many key processes, designed continuously to improve the capability and maturity of an organisation's entire human resources. One would not expect there to be as many processes involved in managing an emergency situation, as the number of staff involved and range of activities are lower
Plans and exercises will be less indicative of higher level capabilities	Whilst exercises and emergency plans give a good indication of the capability of an organisation, it is not expected that strategic, higher level processes will be identified visibly through exercises and plans. Therefore, one would expect that exercises and plans will give some indication of performance at levels 2 and 3, a lesser indication of level 4 performance and very little, if any indication of level 5 performance
Set of core emergency management processes for any response	From the study up to this point, one could hypothesise that at a basic level, emergency management is made up of the same processes as organisational management. These core processes should be identified through the data analysis. In addition to the core processes there will be additional processes that are unique to emergency management. These should also be identified in the data, and contribute to the construction of the new framework in Chapter 6.

This chapter will begin with an analysis of the results from pilot interviews conducted with several response groups. It will be followed by the analysis of emergency plans, beginning with a brief description of each plan's structure and presentation. This will then be followed by a plan analysis using the

assessment checklist defined by the NAO in their report (NAO 2002). Described in the literature (2.6.2); this is a checklist-based plan assessment, divided into several sections. Twenty-two of the original indicators are relevant to non-health emergency planning, and each plan has been assessed against these. This method of plan assessment has been used successfully by the NAO, and could provide some useful comparisons or illustrate some relationships that can be taken forward in the CMM based plan assessment. When all the plans have been analysed in this way, a summary of the evidence of PCMM processes found in the plans will be presented.

The second section of the analysis will be based on data from the investigation of eight MAHI sites conducting emergency exercises. Each case will begin with a summary of the exercise, giving the background information on the site and details of the particular scenario. The PCMM processes that have been identified in that exercise will then be described individually. Any additional processes observed will also be noted and an analysis of the feedback and learning mechanisms will be shown.

In the concluding section, the outcome of the hypotheses will be discussed, the relevance of the original PCMM processes to emergency management, as indicated by the plans and exercises will be described. Comments on the scenarios, plan types and feedback may be noted and will be used in the construction of the new emergency management framework in Chapter 6.

5.2 Pilot interviews

The objective of the pilot interviews was to provide some background information and an indication of the contemporary issues in MAHI emergency management. Three interviews were conducted in the same geographical area to ensure that the research aims were in line with industrial requirements, and that the main issues had been included in the review of literature. The semi-structured format of the interviews gave the interviewees the flexibility to discuss issues which they considered important. Four main areas of discussion were opened with the interviewees, which were: their views of the multi-agency response in their area; if they had response targets and what they were; their views of the emergency plan; and any other problems they felt were important. The conduct of the interviews is discussed in the Methodology, subsection 4.6.

The following paragraphs will discuss the key points of each interview in turn, followed by a summary of the issues which are highlighted by more than one of the interviews. As with all data in this study, any name, chemical, location or other factor that could be used to identify the cooperating organisation has been removed or changed to protect that organisation's confidentiality. The censored interview transcripts are available in the Appendices.

5.2.1 Interview with Major Accident Hazard Pipeline operator

The first interview was with the operational emergency planning advisor for a UK pipeline operator. The particular organisation has a number of sites and pipelines across the UK. The interview began with a description of the regulatory regime appropriate to Major Accident Hazard Pipelines (MAHPs).

The Pipeline Safety Regulations (PSR) 1996 did not stipulate a frequency with which pipeline emergency plans should be tested, in anticipation of the COMAH (1999) regulations, providing a combined approach to plan testing. [This combined approach had still not been adopted by 2003, when this thesis was completed].

The interviewee raised the issue that there is a political aspect to emergency response assessment, as the emergency services and Local Authority (LA) are regulated by the Cabinet Office, and hazardous industry is regulated by the Health and Safety Executive (HSE). This difference in regulators effectively means that while hazardous industry is expected to maintain a consistent approach to emergency response across the UK, they have to work with different LAs who have vastly dissimilar planning methods and structures. Regional differences in emergency services also cause some problems of the hazardous operators, when trying to approach their emergency responsibilities in an integrated manner across the country.

The interviewee went on to mention the problem of a lack of consultation by LAs in the emergency planning process. Different LA emergency plans include various versions of this operator's response, which the operator assures us is exactly the same at any location. This error could be dangerous, as certain plans state that it is the responsibility of the emergency services to define the safety cordons and approach routes during an incident. Only the operating company has the necessary expertise and technical equipment to define the safe areas, and so the responsibility clearly lies with them. The operator also confirmed that they have standard response targets nationwide.

The interviewee was keen to state that his organisation drew a distinction between emergency response and pipeline incident response. The latter was tested and practiced regularly when a leak was detected or reported, many times each day across the UK. The former was rarely used, and only when people, property or the environment were at serious risk from that leak. If a regulatory regime were to recommend a specific frequency of testing, then it should recognise the need to test the rarely-used emergency procedures rather than the regularly-used incident response actions.

5.2.2 Interview with County Police Emergency Operations

This interview was held with two police inspectors responsible for County Emergency operations for a specific area of the UK. The interview began by discussing MAH emergency planning and management and the nature of the police involvement.

The interviewees clarified that the organisational structure of the police in an emergency response comprises three levels of bronze, silver and gold. Bronze level is located as close as safely possible to the incident, and it is from this point that the operational issues are tackled. The police rely on the Fire Brigade to define a safe location for Bronze control. Silver control is the tactical command centre and is located at the nearest police station to the incident. It usually acts as a communications hub for the emergency services and as a resource base. At gold level, strategic commanders meet with the

Chief Executive of the LA and Chief Fire Officers to discuss the overall picture of the incident. Gold control is rarely required and usually located in the county police headquarters, as the police have overall control of a situation of that magnitude.

This system conflicts with some of the agencies involved, as LAs often have their own version of 'silver control' known as the District Emergency Command Centre. The role of this centre in relation to police Silver control causes some confusion and the interviewees recommended that it should be addressed in any new plans and procedures.

The police were keen to state that the primary goal of their response is to protect life, and many of the procedures involved in a MAHI emergency situation are the same as those performed by officers in the course of their regular duties. These include tasks such as diverting traffic and communication with the public and the media. There should be some distinction between the need to exercise the rarely used emergency procedures, and the acceptance that some tasks are practiced and proven to be effective and efficient. The police considered this especially important, as the COMAH regulations allow the emergency services and LAs to charge MAH operators for their time participating in exercises and plan tests. If the regulations were interpreted strictly, the number of major exercises and the cost of police involvement would be prohibitive to industry.

The police regard the LA's County Emergency Plan as a summary of the joint incident procedures rather than a working operational document. In this case the plan is too large and verbose to be useful to the police in an incident, so the police have A5 booklets describing their operational procedures.

In this county there is an emergency planning group consisting of representatives from the different stakeholders in emergency planning. It is seen as a useful communications and coordination forum to improve relations between the parties. In terms of performance targets, the police regard the 'Dealing with Disaster' documents from the Home Office as their target level, and are confident that they achieve those standards.

5.2.3 Interview with a County Fire Service Divisional Officer

In describing the fire service response to MAHI emergencies, the interviewee explained that while procedures have to be flexible to deal with minor and major incidents, the majority of the fire service response is based around the experience of the officers from previous incidents. They compare their experience with their assessment of the current situation and choose the most appropriate action. The first consideration in attending a chemical incident is planning a safe route of approach. This is coordinated by the control room with advice from the chemical data services.

The interviewee expresses their concern that many MAHI sites are reducing on-site fire-fighting resources as a cost-cutting measure. This can be detrimental to the quality and speed of response, as the local fire service has

to respond from a remote location and are not as highly trained in dealing with particular incidents as site-specific fire-fighters are.

The fire brigade carry decontamination showers which are for the use of their officers, who would be in protective clothing. They are not responsible for decontaminating casualties, a job which lies with the ambulance service.

National quantitative performance standards exist in the fire service, and their primary target is response time. Residential areas are categorised 'A', 'B' or 'C', according to the value of the property in that area. Industrial sites are dealt with on an individual basis.

5.2.4 Interview with Local Authority Emergency Planner

The interviewee raised several concerns about the role of other agencies in MAH emergency response. The Emergency Planners found it difficult to establish a working relationship with the police because officers in the role responsible for emergency management change frequently. The interviewee also voiced a reluctance to use the police as an information source during an incident, preferring instead to use other local contacts within the chemical industry.

The interviewees were concerned about hazardous sites cutting their on-site fire-fighting capacity, because the local fire service are not as experienced on hazardous chemical fires, and are not sufficiently familiar with site procedures. Concern was also voiced about the unwillingness of hazardous operators to declare an off-site incident. Their aim is to safeguard their reputation but they risk delays to the response of the LA and local emergency services which can result in a less effective response.

The final comment from the interviews was that they had difficulty on several occasions getting technical advice from industry relating to the chemical involved or contamination issues during exercises. Delay in receiving this information during an incident could result in a slower response from the Local Authority.

5.2.5 Conclusions from pilot interviews

The importance of plan and response coordination between the agencies was highlighted by all three interviews. The police and hazardous operator went further and mentioned specific problems in these areas. The fire brigade assert that in chemical incidents, they rely on information and data rather than their experience, and if that information is not available quickly, their response may be delayed. This view was echoed by the Local Authority. This suggests that MAH site or pipeline operators should determine what information is needed by the emergency services, and ensure that it can be provided in the plan or as early as possible in an incident. The pipeline operator mentioned the urgent need for greater consistency between the responders' plans and procedures. The roles and responsibilities of the responding organisations should be clearly identified in the plans and tested, to avoid confusion in an incident. The importance of performance standards and targets for emergency management was recognised by all the interviewees.

All three interviews brought up the issue of exercising only the sections of the plans and procedures which are not carried out in the regular work of the emergency services and hazardous operators. The interviewees believed that the COMAH regulations would require demonstration of the full emergency plans for each COMAH site, whereas there are many comparable elements of the response which need only be demonstrated once. If the regulations were taken literally, this attitude to testing would result in unnecessary commitment of time and resources from the emergency services and hazardous installations.

The interviews have proved useful as an introduction to emergency management of major hazard incidents. The interviewees illustrated the importance of inter-agency cooperation, coordinated planning and communication. They also highlighted problems relating to the regulatory regime and the need for structured, coordinated testing and exercising of procedures.

Several points from the interviews will be explored through the analysis of plans and exercises. The importance of coordinated, multi-agency response is highlighted by the interviewees, and this supports the use of LA off-site plans as the sample for emergency plan analysis. Secondly the interviewees raised the importance of clear roles, responsibilities and information sources. These are areas specifically explored by the NAO plan assessment checklist, and so this strengthens the use of the checklist as an analysis tool for this study.

5.3 Analysis of Emergency Plans

The pilot interviews indicated a need to look at the multi-agency response, and so the plans used for this part of the research are from different organisations than those that took part in the exercise observation. This provides a wider scope than using just one set of organisations for the whole study, and also gives an insight into how organisations work together in planning a combined response.

What is observed in an exercise should be closely related to the procedures and practices written in the plans, so using the plan and exercise data from the same organisations would be useful for confirming an organisation's internal consistency, but would do little to provide a cross-section of the processes undertaken to produce an industrial emergency response.

The methods of analysis will firstly examine the plan as a document, in terms of its construction, presentation, and ease of use. Secondly, using some (health specific indicators removed) of the indicators given by the NAO (2002: 46) in their checklist of Health Authority emergency plans, the content of the plan will be analysed. The checklist is comprehensive in its coverage of the major planning requirements detailed in the literature, and forms a useful, indication of the content of a plan. Figure 5-2 shows the comparison of all analysed plans against the check-list. Finally, the content of the plan will be analysed for evidence of PCMM indicators, showing the processes found in

each plan in tabular form. The plans have been assigned codes to protect the identity of the organisations involved.

5.3.1 Analysis of plan SA

Plan SA was written to deal with major accidents in high pressure gas pipelines across a particular county in England. This plan can be applied to any incident on any pipeline in the county, and is a coordination document to bring together the response of the emergency services (ES), pipeline operator (PO) and local authority (LA).

As a document, the plan is well presented and reads easily. It is concise and well organised, however it is not physically indexed to allow rapid reference to particular sections. It aims to be specific enough to provide guidance to responders, and flexible enough to be applied to any likely incident. The format of the information however, does not facilitate use in an incident because it is not in a chronological order representing a potential sequence of events. It is clear that the plan has been carefully constructed, however its aim of coordinating a multi-agency response is difficult to judge, as there is a lack of information on joint training, exercising or overall incident coordination.

SA scores fourteen out of a possible twenty-two points on the adjusted checklist, scoring particularly well in the section relating to the ease of application of the plan. There is evidence to suggest that the plan is subject to regular updating, especially in the thorough understanding of risk demonstrated; however there is weakness in commitment to training and exercising of the plan. The plan also illustrates a detailed knowledge of the response actions of the pipeline operator, but gives a contradictory outline of how the coordinated response takes place. While the plan only scores five out of a potential nine points for its detail of the elements of the response, it states that the relevant agencies' Standard Operating Procedures (SOPs) should be used in conjunction with the plan. Taking this into account, one would expect the plan to have a cohesive and strong coordinating influence throughout, which it does not.

One difficulty with the NAO framework is that the checklist focuses on the presence or absence of a plan attribute. The original version incorporates a simple scoring system, however there is no way of qualifying the adequacy of particular aspects of the plan or judging the depth of content. Although training and exercising are mentioned in the plan as being important, and coordination of efforts was required, the plan fails to lay down a mechanism, timescale or commitment. Therefore it scores the point for the reference to training and exercising in the document, but in reality there might be little substance behind the statements.

5.3.2 Analysis of plan UA

This plan is a LA off-site plan for areas which could be affected by a COMAH site emergency near this large city. The plan is a template which has been applied to each of the sites in the area, with the purpose of coordinating the

off-site response of the Site Operator (SO) emergency services and LA to any incident.

The plan is a large document and is unwieldy to read or use. There does not appear to be any logic to the structure of the document. The document makes no use of graphics or diagrams other than simple tables. The level of detail given in the plan is high, but without structure it loses value.

The plan reaches just nine of the twenty-two targets set on the planning check-list; some of those are barely present. There is only a short statement indicating that the plan forms part of a continuous process, and no means of updating and recording revisions to the document. Brief reference is made to the COMAH regulations, but no indication of how they have influenced the plan is given. The plan gives no details of back-up procedures should there be a transport network failure, or any indication of how the events of an incident will be recorded and logged. There is very little guidance in the plan on how to achieve the response tasks. More seriously, there is no indication that any form of debriefing or learning would take place following any incident. There are no procedures in place for such follow-up activity, or even the mechanisms for psychological support for victims, responders and connected parties. The plan provides details of the hazards at the site, but not of the risks posed by these hazards. The plan scores low for its lack of clarity, order and structure. Although the roles and relationships of the responding agencies are detailed, the plan fails to consider trans-boundary incidents and their coordination.

5.3.3 Analysis of plan BA

This plan is designed to coordinate the response to major hazard pipeline incidents within a county in the UK. The county is home to a range of pipelines, including natural gas, petroleum products and toxic gases. The plan is an overall county plan, and contains details of the response to all pipeline incidents. The plan is printed in colour coded sections for ease of use, and is indexed and structured well. The main sections of the plan are 'activation' followed by 'immediate response'. Key messages are presented in highlighted boxes, and the presentation of the plan is effective.

The plan scores sixteen points from the twenty-two available. It provides a good indication that the plan should be maintained and updated, but gives no detail. It refers to the legislation on which it is based, and gives indication of where further details can be found. The procedures in this plan for alerting and initiating are clearly laid out and very easy to follow. Such procedures would be useful to the relevant agencies during an incident. Roles and responsibilities are also clearly stated in a structured manner. There is no indication in the plan, of the importance of keeping a detailed log of the incident. Such a log would be the basis for learning from the incident, and support any decisions should there be legal repercussions of the incident response.

The plan gives details of the communications systems to be put in place, and the procedures for immediate incident control. The procedures are written in

large text within shaded boxes, which make them ideal to be read and understood rapidly in an incident. There are no action cards for responders, and although facilities and reception centres for victims and families are mentioned and a detailed media response is outlined, there are no arrangements for debriefing of any sort. Debriefing is a key aspect of learning from an incident or exercise, and also provides the first steps towards psychological recovery for the individuals involved. It is a serious omission from the plan.

The plan provides details of the various hazards, and brief information on the risks. Detailed risk assessment details are not present however. The plan is well indexed, and has additional information in the appendices. Although some key parts of the plan are brief and concise, other parts are too lengthy and as a result the document is rather large. Locations of the county's school's and care facilities are included in the plan, which requires regular attention to ensure that it is up-to-date. The details of each organisation's role are given, along with brief recognition that pipeline incidents could develop into trans-boundary incidents, and as such procedures should be in place. There are, however, no such procedures detailed.

The flaw with the check-list method, stressed again in this analysis is that it provides only a core indication of whether a task or plan element has been included, rather than an indication of the extent or adequacy to which it could be fulfilled.

5.3.4 Analysis of plan NA

This plan relates to incidents which could occur on a section of a particular hazardous pipeline in a county. The pipeline is only used for natural gas, so there is only one hazard and one pipeline operator to deal with. This plan is presented in a very clear style; each page is sub-divided and clearly labelled. Sections are also clearly labelled and the plan follows a chronological structure, including clear maps of the pipeline and surrounding area and a glossary. A uniform style is used for all of this county's plans.

This plan provided evidence that amendments were treated seriously, and a statement to the effect that incidents should influence the improvement of the plan suggests that continuous improvement had been considered. The Pipeline Safety regulations (PSR) were cited as the basis of the plan, and the duties placed on the PO, LA and HSE by the regulations are also quoted. The operational response is described clearly, in a manner which could be used in an incident. The plan also states that a multi-agency debrief is required as soon as possible following the incident to 'make meaningful contribution to the post-incident investigation'. It suggests that all agencies should produce and circulate a post-incident report, and the plan should be adjusted in the light of the reports. There is no support indicated for this learning ethos with a structure of logging and reporting during an incident however. Media arrangements are clear and functional, and there is a brief but operational description of the risk and hazard. The plan is self-contained and useful additional information is stored in the appendices. The possibility of trans-

boundary effects is recognised, but no procedure or protocol is given. It scores highly, with eighteen points out of the total twenty-two.

5.3.5 Analysis of plan NB

Plan NB is from the same Local Authority as plan NA. It is written as the off-site plan for a major accident hazard chemical site within the county. The plan was written in 1998 to satisfy the CIMAH Regulations, but with the knowledge that COMAH was to be introduced a year later. It was therefore constructed with the draft COMAH requirements in mind. The chemical site deals with four hazardous chemicals, although they are similar in their nature and mechanisms of hazard. It is useful to compare two plans written by the same authority to satisfy different regulations and deal with different hazards. It is expected that the three analyses here will highlight the similarities.

The plan is very similar in style and presentation to plan NA. The LA has applied a distinctive style to all their planning documents, which creates a consistent familiarity. The plan begins with general details of the site, followed by initial response and further response. The annex contains detailed role descriptions for the responding organisations.

This plan scores twenty points from a possible twenty-two. There is a section in the plan which gives the mechanism for continuous improvement, and the requirement for post-incident reporting is emphasised. The clarity of presentation makes it easy to read and understand the initiating and alerting structure, and the roles are clearly defined. Incident debriefing is recommended for operational staff in the interests of learning from the experience. A mechanism for psychological debriefing for the victims or respondents is also provided. Arrangements are in place for a back-up communications network; however there are no procedures to deal with transport network disruption. The plan details the four chemical hazards on site and the risks they pose to people and the environment on and off the site. As with plan NA, the style makes the plan much easier to use, and so one could imagine it being useful in an emergency situation. Although the possibility of a trans-boundary incident is recognised, there are no procedures or policy provided to deal with such an occurrence.

5.3.6 Analysis of plan UB

This plan is from the same LA that wrote plan UA, but rather than hazardous sites, it describes the response procedures for certain hazardous pipelines in the county. The plan specifically deals with natural gas pipelines.

The plan is very similar in presentation to the UA plan. The plan is badly subdivided, and it is not easy to find the appropriate information. The order of the sections is not logical, and so would make the document difficult to use during an incident. Straightforward pages of unbroken text make the plan difficult to read, and there has been no attempt to summarise information in tabular or chart form for quick reference.

The plan score is similar to the first plan from this LA, but scores four points more. It contains a requirement for a six-monthly updating of the plan, and gives the mechanism for providing amendments to the plan authors. The plan provides all the necessary initiating details, but as previously mentioned, the presentation does not make it conducive to rapid response. There is no evidence from the plan that logs or records of an incident should be kept by any of the respondents. The back-up communications protocol as well as the structure and technology of the primary communications systems are also present. There are no procedures for debriefing victims or respondents outlined in the plan. The single hazard and risks are presented in the plan in sufficient detail to aid the response. The plan is difficult to read and use, and as such fails to score any points in the 'clear and unambiguous' section.

5.3.7 Analysis of plan XA

This emergency plan is for a nuclear licensed site. It details the response to an incident on the site which could have effects beyond the boundary. Some of the response details are kept in separate documents for security reasons; however it is not anticipated that this will affect the analysis. As the regulation of the nuclear industry is quite stringent in the UK, it is expected that this plan will be more clearly defined and contain more concise detail than some of the other plans in this analysis.

The plan is clearly laid out, well structured and very concise. As an overview of the expected emergency response, it provides a sufficient level of detail. It is not designed to be an operational document, and refers to the operational procedures documents where appropriate. The plan is written with knowledge and experience of how the procedures work in practice, through exercising and real incidents. This plan is written in an authoritative style not seen in the previous plans reviewed.

The plan scores fourteen points from a total of twenty-two. This is partly due to the nature of the emergency plans for this specialised sector. Several of the check-list items are identified as being present in other documents, and so the inflexibility of the check-list method does not permit these points to be credited as part of the plan.

Evidence of plan updating and amendment control can be seen. However, details of the continuous nature of the process are not included in this level of planning. The plan does not contain reference to the legislation, but provides a clear breakdown of roles, responsibilities and resources required for an emergency response. In common with all other plans analysed so far, there are no action-cards or checklists included as part of the plan. There is also no mechanism for operational or psychological debriefing in this plan, but these activities are part of a related document. The plan is easy to read, concise and well structured, and accounts for the possibility of a trans-boundary emergency. The difficulty in assessing this plan with the check-list method is that it is a part of a portfolio of response documents, which should be judged as one plan. Unfortunately the remainder of the portfolio is classified as 'restricted' due to its sensitive content and was therefore unavailable to the researcher.

5.3.8 Analysis of plan OA

The document was designed to detail the contingency arrangements for response to a MAH pipeline emergency within a Scottish county. There are several pipelines, and the plan details the overall response and the specific elements for different pipelines.

The plan is presented in five sections, indexed with numbered dividers. Although it does not use diagrams or charts, the plan is presented to a good standard and the text is broken down into structured sections. Overall though, the plan spans over 200 sides and is not concise enough to be easily navigable. The plan maintains a lively and comprehensive style, and is written authoritatively.

This document scores well in areas where other plans have failed, and badly in some usually high scoring indicators. Overall it scores twelve out of a possible twenty-two. There is evidence of an amendments sheet, version control and statements relating to continuous review of the plan. This indicates that the plan authors are forward thinking and aware of the dynamic nature of emergency planning. The plan also provides details of the hazards and risks, and the regulatory basis for the plan and response. Roles and responsibilities are detailed separately alongside each hazard in the plan. The plan states the importance for each agency to keep an accurate record of the incident for use during the response and in any later activities. The plan does not provide information on the communications system, or any back-up measures for communications in an incident.

There are no arrangements for dealing with the media, relatives or VIPs in the plan, which is quite a serious omission. Neither is there indication of any allocation of resources for the response or communications arrangements. The plan is risk-based and easy to read, and is physically divided into structured sections. Despite its size, the plan refers to other documents for some operational details of the response. It does not contain reference to incidents which may have trans-boundary effects.

5.3.9 Analysis of plan JA

This plan is a recently released county emergency plan, designed as an all-hazards approach to the subject. It states that its aim is to focus on the common procedures of the responders, rather than the detail of responding to specific incidents.

The plan is heavily indexed using physical dividers. The plan uses graphics, different fonts, colour and charts to present information in a user-friendly format. Master copies of checklists and forms for individual roles are included. The plan is structured in a logical, chronological order to facilitate use during an incident.

This plan scores full marks on the NAO check-list, being the only plan that includes check-lists for each role, in addition to the other facets of the assessment. This plan is the youngest of the set, written in 2001 closely

followed by SA then NA and NB written in 1999-2000. The other plans were written between 1997 and 1999.

5.3.10 Summary of plan analysis

The table below gives the plan identifier across the top and the indicator down the side. The key below shows the definitions of the indicators.

Figure 5-2 Plan summary of NAO checklist performance.

	SA	UA	BA	NA	NB	UB	XA	OA	JA	Tot
1	✓		✓	✓	✓		✓	✓	✓	7
2			✓	✓	✓	✓		✓	✓	6
3	✓			✓	✓	✓		✓	✓	6
4	✓	✓	✓	✓	✓	✓		✓	✓	8
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	9
6	✓	✓	✓	✓	✓	✓	✓		✓	8
7					✓		✓	✓	✓	4
8	✓	✓	✓	✓	✓	✓	✓		✓	8
9	✓	✓	✓	✓	✓	✓	✓	✓	✓	9
10								✓	✓	2
11	✓	✓	✓	✓	✓	✓	✓		✓	8
12			✓	✓	✓	✓	✓		✓	6
13			✓		✓	✓	✓		✓	5
14				✓	✓				✓	3
15	✓	✓	✓	✓	✓	✓		✓	✓	8
16	✓		✓	✓	✓		✓	✓	✓	7
17	✓	✓	✓	✓	✓		✓	✓	✓	8
18									✓	1
19	✓		✓	✓	✓				✓	5
20	✓			✓	✓		✓		✓	5
21	✓	✓	✓	✓	✓	✓	✓	✓	✓	9
22			✓	✓	✓	✓	✓		✓	6
Tot	14	9	16	18	20	13	14	12	22	

Key of Figure 5-2 - indicators and their meanings.

No.	Indicator description
1	Evidence of amendments sheet, stated when plan was last updated and by whom
2	Evidence of version control and a style conducive to a continuous process
3	Evidence of a statement saying the plan was under constant review
4	Evidence of reference to relevant guidance/legislation
5	Clear alerting and initiating procedures
6	Clear statements of roles and responsibilities
7	Clear arrangements for relevant incident response team, documents and logs
8	Coordination of communications at the scene
9	Clear procedures for immediate incident control
10	Action cards for staff and functions
11	Arrangements for relatives, media, VIPs
12	Clear allocation of resources for response
13	Clear arrangements for failure of communications or transport disruption
14	Arrangements for debriefing and subsequent support for staff, victims and relatives
15	Plan identifies risks and hazards
16	Easy to read language and format
17	Plan has comprehensive index and cross reference as appropriate
18	Action cards / checklists are accessible and prioritised
19	Plan does not require use of other documents not included in appendix
20	Brief and concise, containing key information only
21	Statement of key organisations and roles
22	Indication of trans-boundary procedures and interface

The following subsection analyses how the CMM processes are represented in the emergency plans. Each process is described in terms of how it appears in the different emergency plans, identified by their codes.

Training and development

The plans address this process in different ways, but primarily they advocate joint exercises between the responding agencies. UA, SA, NA & NB state clearly that the responsibility for training lies firmly with the individual organisations. Only NA and NB go further than simply stating this, by including information on the LA's exercise diary, an attempt to keep a record of all emergency exercises planned in the county, to facilitate wider benefit and value.

Work environment

This refers to the process of ensuring that the response environment is safe and facilitates an efficient response. SA details the Personal Protective Equipment (PPE) that can be used, and the different personnel that will respond from different locations. BA, XA, NA and NB refer directly to the 'bronze, silver and gold' command, recognising operational, tactical and strategic staging points for the response. Each level has different resources and capability. JA is the only plan which provides details of the equipment at each location, and details of procuring extra equipment for the response if necessary. NA and NB give information regarding the risk-based process for

As the NAO scores have been described individually for each plan, it is sufficient to say at this stage that some of the indicators might be useful in determining the structure and content of the final CMM framework, and their role and application will be discussed when that framework is constructed in **Chapter 6**.

5.3.11 Summary of CMM processes in plans

The plans were also analysed for evidence of CMM processes, and this analysis is summarised in the table below. The plan analysis should indicate if plans contain information on the human element of the response and its maturity, and if so what levels of maturity do plans show. It should also be clear if there are any links between the processes shown and other aspects of the plan, such as its age, purpose and presentation. It is clear from the table that some processes are more common than others, and this will also be discussed further in **Chapter 6**.

Figure 5-3 Summary of CMM processes found in emergency plan sample

Process↓ Plan→	JA	SA	NA	NB	UA	UB	BA	OA	XA
Staffing	✓		✓	✓	✓	✓	✓		✓
Comms & coordination	✓		✓	✓		✓	✓	✓	✓
Work environment	✓	✓	✓	✓			✓		✓
Training & development		✓	✓	✓	✓				
Participatory culture	✓		✓						
Performance mgt.	✓			✓					
Empowered workgroups	✓								

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determining safe locations for the Forward Control Point (FCP). NB and XA also detail back-up ECCs, available if the main control room is compromised.

Communications and coordination

This process demands that the organisation proves that communications procedures and technology are in place to deal with any foreseen incident, and that the coordination structure is clear and understood. This sample of plans are all for multi-agency response, and so the communication and coordination require intricate planning. BA shows the format for the transmission of certain key messages for alert and activation, as well as the back-up measures available. The plan also features the coordination structure of the incident, although due the number of agencies involved, it is not easy to determine from the plan, which is in control of what part of the response. NA and NB also feature the back-up measures should the regular network fail, along with a clear definition of the coordination structure. UB, XA and OA do not contain detail of back-up communications options, although they identify the technology available for communications. OA and JA contain log sheets to record the transfer of information. JA also provides graphical interpretation of the message procedures and highlights the importance of logging and recording decisions.

Staffing

The process of staffing aims to provide adequate numbers of properly trained personnel to deal with the likely consequences of an incident. The plans analysed address this issue in varying degrees of depth. All plans at least provide a list of the organisations involved in the response. This was usually supported by contact details, including a mechanism for call-out during silent hours, where a 24-hour hazard exists, such as at NB. The range of organisations mentioned in the plan varies, with SA planning for catering, triage, environment, evacuation and rest centres, as well as the operational emergency services. BA leaves the judgement of who to call-out until the actual extent of the incident has been determined. NA also includes the facility to extend the call-out should the demands of the incident increase. The JA plan uses a chart to show the levels of staff responsibility in the response. This makes it exceptionally clear what is expected from each of the roles.

Participatory culture

This process requires that there are mechanisms in place for all staff and organisations to contribute to the improvement of the response. Staff should understand and have faith in the system through which they can voice their grievances and suggest enhancements. NA encourages all agencies involved to report on their incident experience and share that report. Joint contribution to exercising is also encouraged.

Empowered workgroups

Plan JA gives a high level of autonomy to the response groups. Each group can procure resources and recruit additional personnel if required. They can also make decisions related to the response, and are given the power and authority to carry out their tasks.

Figure 5-4 Table showing CMM processes

Performance management

This process of performance management requires that targets and objectives are set, and the response is measured to record the achievement of these targets. These objectives should be based on the risks identified and the target achievement should influence future plan development and response. NB and JA exhibit attribute of performance management. JA contains targets in role-specific check-list form.

The processes above will be discussed further at the end of this chapter, and compared to the processes observed in emergency exercises.

5.4 Observation of emergency exercises in hazardous industry

This section analyses the data gathered from eight emergency exercises, as introduced in 5.1. The data collection method for emergency exercise observations was discussed fully in 4.9 and summarised in Figure 4-4. The aim is to determine what combination of processes enables an organisation to continually improve its emergency management capability, and how those processes can be observed and assessed. The observations are expected to show a spectrum of processes, indicating different levels of performance and capability. Using this range of processes an assessment framework for emergency management can be developed.

Each exercise has been assigned a code that is linked to the particular organisation involved. The code does not resemble the site location or organisation's name, thus maintaining the anonymity of the data. This section will conclude with a summary of all the emergency management processes that have been identified from the data. The tables of data and observations from the exercises is lengthy and so is contained in the Appendices to this thesis, Chapter 10.

5.4.1 Conclusions of exercise observation process analysis

The table Figure 5-4 shows the CMM processes that were observed at each of the eight sites visited. There were also some additional 'novel' processes which will be discussed later in this chapter. The table shows that there are four processes which are clear in every exercise observed, and there is also some similarity with the processes found in the emergency plan sample. The processes themselves are summarised in Figure 5-5 giving details of how they were apparent at the different sites. This table is followed by the overall conclusions of this chapter, and the information that will be taken forward into Chapter 6 to present the results.

Figure 5-4 Table showing CMM processes evident in exercises

Process↓	Site→	GA	MA	RA	HB	HA	ZA	DA	WA
Staffing		✓	✓	✓	✓	✓	✓	✓	✓
Comms & coordination		✓	✓	✓	✓	✓	✓	✓	✓
Work environment		✓	✓	✓	✓	✓	✓	✓	✓
Training & development		✓	✓	✓	✓	✓	✓	✓	✓
Workforce planning		✓		✓		✓		✓	✓
Quant. performance mgt.		✓	✓			✓		✓	✓
Competency analysis		✓		✓	✓				✓
Workgroup development		✓		✓	✓				✓
Performance mgt.		✓			✓				✓
Org. capability mgt.								✓	
Competency development			✓						
Participatory culture		✓							

Figure 5-5 on the following page comments on each of the processes on the basis of the evidence from the MAH sites. The process notes are based on the compound knowledge from all the sites, and the numeral in brackets in the first column is the number of occasions out of the total eight that the process has been proven. This table will be followed by the overall conclusions from the Data Analysis.

Figure 5-5 Table describing and summarising CMM processes in exercises.

Staffing (8)	A vital lower level process, shown in every organisation. Carried out to varying extents, ranging from large experienced teams with dual-role members, to small, fragile teams. Most sites with 24 hour response, although some to insufficient standard during night. Most staffing was based on needs identified from site risks, however one site was based on the number of staff of a suitable seniority to be EMS. Without this foundation process, rest of CMM processes not sustainable.
Communications & coordination (8)	The process was demonstrated at several levels. Variables included the suitability and level of technology of the equipment, and the quality of communication within the EMT, between teams, between the team and the site, and between the site and the media and external response agencies. Can also be considered in terms of displayed information, interpersonal communication and message handling. This is an important process and is considered by the industry to be central to emergency management.
Work environment (8)	Importance of equipment and facilities to enable a safe and efficient response had been recognised by most sites, only one recorded as having inadequate ECC. On all sites fire fighting facilities were of a good or excellent standard, and medical facilities were above the required level. Custom designed facilities and equipment were more appropriate than converted or multi-use facilities. Some demonstrated back-up capabilities, but most of a very basic standard. FCP standards not observed in this study.
Training and development (8)	Details of the training programme were discussed before the exercises, and the results of the training were seen in the management of the scenario. Training and development practice ranges from irregular unstructured exercises to comprehensive selection, training and refresher programmes. Factors included the EMT writing training modules for incident control staff, training with external emergency services, training EMT for back-up roles, and running selection programmes and keeping records of training progress and development. Very important process, perhaps not perceived as such, but crucial foundation for people-based CMM approach.
Workforce planning (5)	This process ensures that the workforce ability is matched to the current and future demands and objectives of the organisation. This process is apparent through evidence of procedures to back-up EMTs, willingness to change emergency management system to adapt to change within and outside the site, and other measures to ensure the flexibility and reliability of the response. The commitment to a 24-hour response availability is also noted.
Quantitative performance management (5)	Quantitative targets enable a structured and objective approach to performance management. The sites which showed evidence of this process had mainly operational task targets for muster completion, rescue of casualties, ECC activation and fire response. Setting targets is the first stage of the process, followed by recording targets, assessing and recording performance and adjusting the target or the performance following the assessment. Targets should be used as a basis for action, otherwise they serve little purpose. Targets should be evident before, during and after the exercise.
Workgroup development (4)	This process aims to increase the intra-dependence within teams, and reduce their reliance on other teams to complete tasks. The process is evident on three sites, where it is clear that there are efforts to increase team cohesion and make teams inwardly stronger. Examples include maintaining the same teams for training and on rota, and ensuring that the disbanding process at the end of an incident aims to record tasks, progress and achievements to preserve team assets and knowledge. Formalised records are again an important part of this process.

Figure 5-5(continued) Table describing and summarising CMM processes in exercises.

Performance management (3)	In order to measure performance, there must be objectives against which it can be compared. The three sites which show evidence of this process had mechanisms for logging, analysing and learning the lessons from exercises and incidents. This information was then reported and produced as an action plan to guide response improvement. One site has a formalised exercise assessment tool which gives structure to the task of assessing, feeding back and implementing changes from exercise or incident performance. It is also important that the site demonstrates the commitment to change as a result of the lessons learned, and provides the resources to implement such change.
Competency analysis (4)	The analysis of tasks and distilling into competencies takes place on three sites at varying levels. On other sites there seemed to be an unconscious definition of tasks into knowledge, skills and abilities, however it should be intentional for the process to be credible. One site demonstrated integrated competency analysis, with documented competencies and training modules aligned to that. Documentation of the process and written definitions of the competencies is important for this process, as it provides a basis for further competency development.
Competency development (1)	This process was only observed on one occasion, and went little beyond competency analysis, but the practice of a competency matrix was considered worthy of the distinction. Each EMT member was given opportunity to practice and refresh each competency for their role through a series of planned exercises and training sessions throughout the year. Senior EMT members also informally took part in training new members.
Organisational capability management (1)	The process of organisational capability management is the consideration of the overall capability in terms of the number of staff to fulfil certain roles against the possible requirements of an incident. One site in the data was seen to maintains a large pool of trained staff to ensure that an EMT can be called out at any time to deal with any incident. The training and maintenance of these staff was based on an assessment of the risk requirements of the site.
Participatory culture (1)	A participatory culture is achieved by a process of continuous communication between the staff and management. One site has regular bi-monthly opportunities for all staff to bring safety and risk issues to the attention of the management, in a process which is recorded and acted upon with feedback given to the original member of staff.

5.5 Conclusions from data analysis

There are four main sets of conclusions that can be drawn from the analysis of the plans and exercises. From observing the feedback sessions there are a number of examples of good and poor practice and recommendations for the planning and structure of emergency incident or exercise debriefing and feedback. There are also comments resulting from the analysis of the exercise scenarios used on the different sites. These will be used later in Chapter 6 to construct the detailed framework and assessment protocol. The main conclusions relate to the overall processes found to contribute to emergency planning and management and any similarities with the processes described in the original PCMM, including a discussion of the hypotheses stated in Figure 5-1. Finally there are some general conclusions drawn from the plans, exercises and feedback regarding the structure of the emerging emergency management framework. This will lead into Chapter 6, the results, where the final assessment framework will be constructed and tested.

5.5.1 Summary of CMM processes evident through data analysis

Section 5.3.10 detailed the processes that were evident in emergency plans, showing in tabular form that some are more commonly used than others. The number of processes visible in each plan is an indication of the plan's level of detail, and also of the level of commitment to and understanding of the emergency management process. It is difficult to judge the actual response capability of an organisation from reading its plan alone, and even more difficult to judge from the multi-agency coordination plan. It would be fair to say that often, emergency planning is much more than what is shown in the physical plan document. Whereas some organisations approach the plan as a means of communicating the procedures and directing an incident response, others see it as a document designed to fulfil a regulatory requirement. The different attitudes result in different plans. Observing exercises however brings a new dimension to the emergency planning.

Figure 5-6 Table showing CMM processes found in data

Process	In plans	In exercise	No of cases	Level
Communications and coordination	✓7	✓8	15	2
Staffing	✓7	✓8	15	2
Work environment	✓6	✓8	14	2
Training and development	✓4	✓8	12	2
Performance management	✓2	✓3	5	2
Workforce planning		✓5	5	3
Workgroup development		✓4	4	3
Competency analysis		✓4	4	3
Participatory culture	✓2	✓1	3	3
Competency development		✓1	1	3
Quantitative performance mgt.		✓4	4	4
Empowered workgroups	✓1		1	4
Organisational capability mgt.		✓1	1	4

Figure 5-6, shows all of the processes found in the data, and indicates the number of individual cases (plans and exercises) they were identified in. There are several clear trends in the data, which support the hypotheses at the beginning of the chapter.

The first hypothesis suggested that there would be fewer overall processes than identified in the original CMM. Numerically, fewer processes are identified, but perhaps more significantly, the process descriptions in 5.3.10 and Fig.58 show that there are some which have close or overlapping characteristics and therefore could be combined and renamed. This refinement of the processes will take place in Chapter 6.

An interesting conclusion from the analysis was that there are some differences between how a process appears in a plan and how it is involved in the exercise. To an extent, some processes also have a third role in the feedback and learning from the emergency. It appears at this stage that rather than there being one set of processes for the preparation, response and learning aspects of an emergency, there are three versions of the same set of processes. This will be explored further in the Results, Chapter 6.

The second hypothesis stated that the plans and exercises would be more indicative of the processes at lower maturity levels. The table (Fig. 5-6) clearly shows that while there are a number of level two and three processes, there are only three level four processes briefly indicated and no level five processes. The level two processes are widely observed in many of the plans and exercises studied, but this is to a lesser extent for the level three and four processes. Overall there are 61 examples of level 2 processes, 17 examples of level 3 and 6 examples of level 4.

The final hypothesis proposed that there would be a set of core emergency management processes which would be central to most cases, and this also appears to be shown in the data. The processes of training and development, work environment, communications and coordination and staffing feature in the majority of plans and exercises, and form a base-line of core activities. There were also some issues in the plans and exercises which might warrant new processes in the final framework. These new processes will be detailed in Chapter 6 as the new levels and processes are constructed.

The second part of Chapter 6 will describe how the new framework was applied and tested by auditing a sizable emergency management organisation, and validated by presenting the framework to a panel of experts for their feedback and guidance. Chapter 8, the Discussion, will criticise the methodology use in this study and discuss the problems encountered and the wider application of the results.

Chapter 6

Results of the data analysis

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Firstly the language and phraseology of the original PCMM was unsuitable, as a significant proportion of the terminology was specific to the organisational management field. Those responsible for emergency management on major hazard sites are generally from an engineering or scientific background, and so use largely technical vocabularies. The meanings of terms such as process, control and feedback are different to engineers and scientists than they are to managers. The language and layout of the framework must also be straightforward and require little or no interpretation if it is to be a fair and accurate assessment.

There was also the issue of scale, as the original PCMM was designed to assess the Human Resources (HR) issues of a whole organisation. Emergency Management is usually only a small part of the organisation's activities, and so applying a large group of PCMM processes to the fraction of the organisation involved with emergency management can result in duplication, redundant processes and inappropriate definitions. Some issues such as the responsibility for safety still apply organisation-wide and will be discussed further in Chapter 8, Discussion.

The resources required to conduct a PCMM-scale assessment of this code should also be considered. To apply the full PCMM to an organisation takes

6 Results

This chapter will show how the original PCMM along with information from the data analysis have been used to construct a new, Emergency Management assessment model, known as the Generic Emergency Management Assessment (GEMA). The chapter will begin by arguing why the PCMM could not be used without significant changes, before describing these changes and how they were made. The chapter will conclude with a presentation of the draft Emergency Management CMM, giving details of the assessment method. Chapter 7, Testing and validation will then show how the model was tested and refined.

From the data collection experience in this research, some recommendations for exercise design and conduct and emergency plan design have been suggested. These will be described in section 10-4, Appendices.

6.1 Designing the new model – variations from CMM

This section will describe why the unchanged PCMM could not be applied as an emergency management assessment and what changes to the original PCMM were necessary to create an appropriate assessment framework.

6.1.1 Why change PCMM?

The data analysis chapter compared the processes found in emergency management systems to the processes claimed by PCMM as being indicators of sound organisational management. This highlighted that although the principal structure and philosophy of PCMM applied equally well to Emergency Management, the assessment method of the model and the processes needed to be significantly changed.

Firstly the language and phraseology of the original PCMM was unsuitable, as a significant proportion of the terminology was specific to the organisational management field. Those responsible for emergency management on major hazard sites are generally from an engineering or scientific background, and so use largely technical vocabularies. The meanings of terms such as process, control and feedback are different to engineers and scientists than they are to managers. The language and layout of the framework must also be straightforward and require little or no interpretation if it is to be a fair and accurate assessment.

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The resources required to conduct a PCMM-scale assessment of this scale should also be considered. To apply the full PCMM to an organisation takes

between three and five months using a team of four to ten assessors, depending on the size of the organisation (Curtis et al 2001). The time and financial commitment from the organisation is high. In the case of CMM and PCMM this cost can be justified against the direct savings of operating more efficiently. Emergency Management budgets are however dominated by the expense of training and exercising, leaving little support for assessment and improvement activities. If the framework is to be successful, it must be easily applied with minimum requirement for additional time or resource commitment from the organisation.

The method of assessment used by PCMM is not suitable for the Emergency management field, because there are insufficient resources to provide additional opportunities to assess the facilities and systems. The GEMA framework should ideally use assessment opportunities that already exist within the organisation for predefined purposes. These opportunities include demonstration exercises for the regulatory bodies, plan reviews and feedback sessions.

This issue was clearly demonstrated in the experience of this study. Organisations were happy to allow the researcher to spend time reviewing documents and answer any queries in a short meeting. Similarly, they were keen for the researcher to attend a site exercise and observe the proceedings, with the opportunity to discuss the outcomes in a short summary meeting. Many of the exercises allowed the researcher to also observe the 'wash-up' and feedback sessions which provided a further level of data. Some sites were even keen to promote individual interviews with particular members of staff. Opportunities for lengthy meetings to discuss the emergency plans or to run a particular scenario for the sole purpose of assessment or research would have been unlikely in any of the organisations who participated in this study. This issue will also be discussed further in Chapter 8, Discussion.

6.1.2 How the PCMM structure has been changed

The PCMM structure has been changed in several ways to address the concerns from 6.1.1. The PCMM processes are grouped into five maturity levels. An organisation must complete all the processes at a particular level in order to be classified as performing at that level of maturity. Each level is labelled, and has a statement of purpose.

6.1.2.1 *Changing the Levels*

The levels in the original model reflected the organisational management focus, and the progression in performance of the whole organisation. These were not appropriate to EM, and so new levels have been defined and named, reflecting the staged improvement in performance and capability of an emergency management system.

6.1.2.2 *Changing the Processes*

The processes have also been changed to make them more appropriate. They have been streamlined into three stages, reflecting the sequential phases of emergency management. This has reduced the number of processes and also simplified the assessment. The descriptions used in the

model now reflect more clearly what each process should achieve (Fig. 6-5) By combining some processes under a different title, restructuring some into phases of a wider process and cutting out several processes that the data collection showed to be inappropriate, the number of processes has been condensed from twenty-two down to eight.

6.1.2.3 *Process qualifying statements*

The original assessment concentrated on four features of how the key processes were managed in the organisation. The new assessment framework also concentrates on four aspects of how the processes are performed, but these 'process qualifiers' are more in line with the demands of emergency management (Fig. 6-3-3)

6.1.2.4 *Assessment protocol changes*

The PCMM prescribes an assessor-intensive programme of interviews and questionnaires spanning several months. Resource constraints and the smaller scale of emergency management systems indicated that the assessment needed to be scaled down. The research methodology confirmed that an assessment opportunity, which did not place additional time or financial burden on the target organisation, would be welcomed by industry, and so a new assessment protocol has been drafted.

6.2 Redefining the levels

A maturity level is a stage in an organisation's capability, which is achieved by carrying out their emergency management processes to a particular standard. Specific practices, tools or methods are not determined in a CMM framework, as the model aims to prescribe *why* but not *how* improvements should be made. By maintaining this rule the generic quality of the model is preserved, and each organisation or sector can provide the appropriate detail and description for their own circumstances. Figures 6-6 to 6-13 will detail each maturity level in turn, stating the key requirements and describing how each process should be carried out at that level.

6.2.1 Level headings

The headings for each maturity level are of prime importance. The heading must encapsulate what it means for an organisation to be at that level of maturity. The words used must be clear and unambiguous, and have the same meaning to an engineer as they do to a manager or to the regulator. The examples of the names from the CMM and PCMM maturity levels are shown below with the new names for the GEMA levels. These headings were chosen after long research deliberations, and some of the rejected options are explored later in the Discussion, Chapter 8. The numbering of the levels has also been changed to reflect the absence of any requirements or processes at level 1. This recommendation came from the expert validation panel, and is explained further in Chapter 7. Note that from this point onwards, the maturity levels will be referred to by their GEMA number, ranging from 0 to 4.

Figure 6-1Maturity level names for CMM, PCMM and GEMA

Level	CMM name	PCMM name	GEMA number & name
1	Initial	Initial	0 Default
2	Repeatable	Managed	1 Functional and repeatable
3	Defined	Defined	2 Focussed and defined
4	Managed	Predictable	3 Measured and integrated
5	Optimising	Optimising	4 Adaptive and optimising

The differences between CMM and PCMM are explained by the literature and are due to the CMM technical focus, for which repeatability is an important early stage. The PCMM focus is on human-based processes, and they must be actively managed before further improvement can be attempted.

A key consideration when designing the GEMA level names was that they could be understood by all agencies and stakeholders in emergency management. PCMM assessment is carried out by Quality, HR and management professionals, in contrast to emergency management, which is the realm of experts and volunteers from a range of technical and non-technical backgrounds. To enhance the clarity and allow ease of interpretation, two-word phrases were chosen to replace the single word CMM and PCMM descriptors. Level 0 does not have any requisite processes, it is simply where immature organisations reside; ‘Default’ was therefore considered to be a more appropriate term for this level.

The following section presents overviews of the maturity levels for the GEMA. The description of each level will begin with an overview, then give reasons why a process should be carried out in a certain way at that level of maturity. Levels 1 to 4 are described, as level 0 is the default level and has no performance requirements.

6.2.1.1 Level 1 – Functional and Repeatable

Emergency management systems which have been assessed as maturity level 1 are able to provide a functional response to an emergency within their portfolio of credible incidents. An emergency plan exists, and if it is implemented, a standard response can be expected to occur. At this level the organisation is accountable for providing a response to incidents which might occur as a result of the hazards under their jurisdiction.

At level 1, the Human Resources Management process ensures that there are sufficient staff to ensure a response, and that they are reliably able to respond to a call-out. The staff responding to an emergency are accountable to the emergency managers for their duties and responsibilities. There is evidence of a good working relationship between the emergency managers and the response teams. The process of Training and Development at this level ensures that each responder is trained to carry out their assigned duties. The training focuses on the perceived requirements of the individuals, to enable them to respond appropriately.

The process of Research and Innovation has not been observed in organisations at this level, as their aim is simply to be able to present a

credible, repeatable response. Innovative solutions might be observed; however the structure is not in place to control or benefit from them and they could go unseen or have undesirable consequences. At this level, the response teams review their performance directly following an incident, to the extent that they discuss the positive and negative aspects. It is unlikely that there will be further analysis of the response, or any learning from it at this maturity level.

The process of response management at this level ensures that there are facilities for managing a response to the credible hazards. This could include fire-fighting and medical facilities. The buildings and facilities provide a stable environment from which the response can be managed. There are repeatable measures in place for initiating the plan and activating the response.

Resources are provided through irregular means at this level, and there is usually no policy or financial commitment to resource emergency management. Risk identification and Assessment does not take place to a significant extent at this level, with emphasis instead on safety and hazard awareness. There may be small scale risk assessments carried out by the fire and medical personnel, to enhance their personal safety during the response, but risk is not assessed at the organisational level.

The final aspects of a level 2 organisation are borne out through Definition of requirements and Response Assurance. At level 1, it is usually only the internal parts of the organisation that receives assurance of a response being effectively administered. There is an internal understanding however, that the managers are accountable for the performance of the organisation in dealing with an emergency.

A level 1 organisation should demonstrate that it understands the requirements placed on it. The emergency plan should show a fundamental understanding of the regulations that it is seeking to address. There should also be repeatable means of defining the immediate requirements of an incident. These could either be physical assets; in the form of gas detectors, alarms and sensors that alert the control room to a certain type of incident, or in the form of written guidelines detailing the response requirements for specific types of incident. The appropriate regulatory requirements for UK MAH industry are discussed in the Literature review, Chapter 2, but in short they require that the site has an emergency plan, the capability to respond and regular testing of the response at defined intervals.

6.2.1.2 Level 2 – Focussed and Defined

At level 2, the response capability of the organisation was performance based. The goal of the plan and individuals involved was to maintain a state of readiness to respond to an incident. The aim at level 2 is to build a focussed response infrastructure of workforce and facilities. A level 2 organisation should be able to respond the risk levels they have defined. For these defined risks, the organisation should be able to justify how it can respond to control and dominate an incident. This justification should be presented in terms of the knowledge, skills and abilities to manage the specific incident, and how

the competencies of the workforce can be applied to the demands of an emergency.

The PCMM asserts that one of the primary goals of this level is to gain a competitive advantage, or 'do better' than your competitors. In the EM context, the hazard is the competition they face, and the organisation must gain an advantage by being proactive in managing the risks that have been defined and focussing their efforts on regaining control, should the risks escalate into an emergency situation.

Level 2 concentrates on building a more sustainable response, capable of dealing with any escalation in risk, rather than simply responding to emergencies. The CMM literature suggested that a more efficient and effective organisation can be achieved by distilling the organisation's committed work into a set of competencies, which could be used to tackle any task that arose. The data also indicated that the competency-based approach to emergency management has been attempted in some of the organisations studied, and that there is scope for further development of the technique.

The HRM process at level 2 aims to provide the necessary workforce to manage and respond to the defined risks. The roles and responsibilities of the responders are defined and clearly recorded in the plan and associated documents. There is a clear structure for the recruitment, selection and progression of emergency management staff, which is focussed on establishing synergy between the full-time responsibilities of the individuals and teams, and the development of their response roles. Individual and team training requirements are assessed, and a record is kept of individuals' training and development. The Training and Development process provides a structured training process, with defined objectives. The training is focussed on developing the necessary competencies in the workforce, to ensure a reliable response.

At level 2, Research & Innovation are used to fill gaps in response knowledge and resources. If a problem is perceived during the response, research can be commissioned to find a solution. Such research is usually carried out within the organisation, and solely focussed on solving one particular predicament. Whilst level 3 organisations are not structured well enough to take full learning advantage of any opportunity, the learning outcomes of any incident are likely to be discussed and analysed by those involved. Learning is focussed within team groups, and lessons or knowledge gained from the response are unlikely to be shared outside the team. Any learning would normally be focussed on solving a direct problem, rather than probing deeper to seek solutions to the root cause.

The physical response requirements at level 3 are defined, and the facilities and equipment are focussed on dealing with the likely risk portfolio. Level 2 response management aims to ensure that sufficient resources are available to respond to risks that the organisation has defined as being likely to escalate to a dangerous level. An organisation performing at level 2 maturity is likely to have carried out a risk assessment, and defined a portfolio of risks, detailing

the scenarios in which certain hazards could become unstable and dangerous. This process is key to level 2, as it provides the portfolio of risks which are revisited by processes at higher levels.

The stakeholders who require response assurance are defined in level 2, and how this assurance will be achieved is recorded as part of the planning documents. The response assurance tasks are focussed on matching the expectations of the stakeholders at level 3, and some work will have been carried out to determine the requirements and concerns of the different stakeholder groups. Response assurance is still reactive however, and assurance activities would take place once an incident has occurred.

At level 2 the emergency plan clearly defines the requirements that it aims to fulfil and focuses on achieving related goals through the response. Individuals and teams in the response show awareness of the overall requirements, and of the specific duties and responsibilities connected to their roles. The teams should be aware of the distinction between the requirements of the external environment in the form of legislation and public pressure, and the physical requirements and limitations of the site and the plant. Both of these sets of requirements should be addressed in the plan, and evident to the assessor through any observations of the EMT.

6.2.1.3 Level 3 – Measured and integrated

When an organisation reaches level 3 it shows evidence of being measurement driven. Emergency management processes are designed to facilitate measurement and assessment. This measurement enables knowledge to be structured and shared more easily, and learning is enhanced. Measurement facilitates comparison on equal terms, which enables organisations to gauge improvement and share improvement strategies. Measurement is also important to formalise a system of monitoring. Criteria and a measurement framework make it much easier to monitor emergency management continually, whereas maintaining a regular schedule of monitoring without a structure is difficult, and usually proves unsustainable.

Without a defined set of common characteristics, comparison of dissimilar sectors and plants throughout MAHI has proved difficult. Earlier in the chapter this set of characteristics, known as 'key processes', has been established, a level 4 organisation would be expected to set quantitative targets for these processes, and monitor progress towards them. Targets should be designed to encourage the achievement of performance standards, and should be set by the teams who will be performing the tasks.

The second aspect of level 3 is integration. This reduces duplication and enhances the ability of all teams to learn from each others' experience and knowledge. Through integration, the organisation widens the number of competencies they can access to complete tasks, known as their 'competency base'.

One of the core reasons given for integration in the CMM model was that it increases the agility and efficiency of interdependent work. By level 3, the

teams' internal structure should be well defined and focussed, and the cohesion between the different teams is the key objective. Integration is especially important for organisations which work extensively with contractors, stakeholders and outside groups, as the increased pressure of an emergency situation can expose any instabilities or fissures in the emergency procedures.

Looking at specific processes at level 3, they all show a closer relationship between emergency management and the everyday business objectives of the organisation. HRM incorporates measurement of staff turnover, recruitment efficiency, and the satisfaction and sustainability of the current personnel. Training is planned and structured to achieve set objectives, and it is then measured and appraised to ensure that it meets them. Numerical training targets are discussed and recorded, and the progress and advancement of individuals and teams is measured against these targets. Integrated training opportunities are exploited by all parties involved, and further integration is continually sought.

The process of Research and Innovation should be integrated with other agencies and organisations. External research might be commissioned, using academic and industrial resources, and research effort is measured and assessed for its value and efficiency. The efficiency of the organisational learning process is also measured at this level. This can be achieved by investigating how far learning penetrates into the organisation, and the longevity of the resulting knowledge. The access to that learning can also be measured, in terms of integrating it across the organisation and across the other agencies involved in the response. Learning at level 3 is also taken forward by formulating action plans, setting measurable targets towards their achievement, monitoring progress and re-testing to check changes. Level 3 organisations also integrate their learning mechanisms with other relevant organisations to exploit the learning available from incidents and experience at other plants or in other agencies.

The efficiency of the actual response is also measured at level 3. Quantitative targets are set and individuals within the teams are responsible for monitoring and recording progress towards those targets. There is a budget allocated for response management facilities and equipment, and financial targets and expenditure is integrated into the normal business of the organisation. Emergency management facilities and resources are managed in the same way as any other organisational asset.

Requirements for the response are expressed numerically, and targets for fully meeting all requirements have been set and are assessed. The requirements have been integrated into a core set of competency requirements for the response. This competency requirement is defined, recorded and progress towards its achievement is mapped out, monitored and measured. These competencies are distributed between the different teams, and the response is competency rather than task focussed. Competency cross-over between the emergency tasks and the everyday business therefore adds benefit to both objectives, and makes both more efficient.

At maturity level 3 the organisation will use quantitative risk assessment methods to assess and prioritise risk. The organisation will also exploit the risk knowledge and experience of its partner agencies in planning its own response. Quantitative methods might also be used to justify levels of expenditure and resources for particular risks, and to support the organisation's emergency strategy through response assurance.

A level 3 organisation would measure the effectiveness of the response assurance using quantitative means. Stakeholder satisfaction and public opinion would be useful indicators for this. Assurance would be coordinated with other participating agencies, and a joint response overview could be developed. Feedback is used to improve and strengthen future response, and make any changes necessary to support more effective assurance.

6.2.1.4 Level 4 - Adaptive & Optimising

The maturity level 4 signifies that an organisation is continuously improving its emergency management system. It has the capacity to detect changes in the demands placed on it, and make the necessary, measured changes to the system to enable the response to cope with the new circumstances and be prepared for any further changes. The organisation shows adaptability through all its emergency arrangements and documentation. It is continuously responding to the precursor conditions which can trigger an incident. These may be internal events, or changes in the external environment.

Optimising means to

"...make something as effective or advantageous as possible".

(Allen 2002: 618)

In emergency management terms, this can mean that the organisation has facilities and protocols in place to learn from any incident or occurrence, and use that knowledge and lessons to its advantage. It should also create positive opportunities from any changes or flux in the external or internal environment, which in less capable organisations would have resulted in negative consequences and potential loss.

At maturity level 4, the process areas are interdependent and integrated to a large extent. Risk assessment and analysis identifies areas of change in the system and environment, and provides the basis for changes and adaptation to the HRM. Personnel and their roles are adapted, and the activities of recruitment, selection and personnel transfer respond accordingly.

The process of training and development is wholly competence-based at level 4. Organisations aim to maintain a competency portfolio which has been measured as adequate, to deal with all reasonable demands identified by the risk assessment process. The competencies are integrated with the regular business requirements of the organisation, and training is planned and structured to meet requirements of emergency and regular duties in parallel. Training and development are also guided by information from the research and innovation process, which continually seeks innovation within and outside

the organisation, and conducts research in order to optimise and improve its processes and the efficiency of the organisation. Effectiveness and efficiency are also continually addressed through organisational learning.

At level 4, organisational learning uses assessment of precursor events and incident response to generate performance information. This will improve the planning and risk assessment stages of the system. This is known as double-loop learning in the CMM literature. Single loop involves response feedback influencing future response, and double loop learning is the use of that same feedback to influence the planning and preparedness for response, and any earlier inadequacy that may have propagated response error.

The response management process has predictive elements, and uses technology to gain advanced knowledge of potential incidents that could escalate beyond control. Facilities and equipment at level 4 are adaptable to respond to any situation, and continually reassessed and developed to adapt to any change. Any investment in response facilities should have a utility focus, to ensure that through regular or continual use of the facilities, use in an incident is familiar and well practiced. It would also ensure that the equipment is maintained frequently and facilities are always ready to respond. Response management is also tightly linked to the research and innovation process, which can be used to develop solutions to any specific technical or response problems which cannot be solved using conventional methods or technology.

Level 4 also sees the complete shift from task-focussed response, to competence-based operation. Rather than teams focussed on achieving separate parts of the response, the organisation is now configured to deal with an emergency as a deviation from their normal operations, and to as greater extent as possible, the competencies which equip the workforce to carry out their regular work also enable them to deal with the different conditions of an emergency situation. The competency basis removes the problems associated with disjointed emergency management procedures. It lapses in training and practice, resulting in poor retention of skills and knowledge. Competencies are used daily through scheduled work, and so are continually improved and maintained. There is also no potentially difficult transition from normal to emergency conditions. The organisation simply applies its competency base in a different way to deal with the novel circumstances, and adapts seamlessly to quickly regain control.

Risk identification and assessment at level 4 is a cultural feature of the organisation. Focused management of change ensures that operations are continually monitored for any variation from the intended processes, structure or functioning. The monitoring is automatic, integrated and also instilled within the workforce. Risk assessment is a formal and documented process, which precedes any change or major decision affecting the organisation. It is also integrated with safety at shop-floor level, where the responsibility for accident prevention and prediction lies with every member of the workforce. Such information and knowledge is used to bring the problem to the attention of the department or individual with the responsibility to rectify it, and measures are

planned and implemented to address the concerns. The results of the matter are then fed back to the individual who discovered the problem, and the wider workforce. This creates a culture of continual learning and improvement.

Definition of requirements and response assurance process at level 4 is further integrated and continuous. All stakeholders are part of a consultative process of requirements definition, in which their expectations and demands are explored and the organisation provides a structure through which the concerns and requirements will be resolved. This process is in parallel with Response Assurance at level 5, because the organisation structures its assurance mechanisms to directly meet and exceed the requirements of all the stakeholders. It also retains the capacity to respond to any new stakeholders or assurance demands, continuously assessing the environment for both new demands on the organisation, and new demands for assurance.

At level 4 the processes are more strongly integrated and interdependent than earlier in the model, where they were convoluted and working separately. The definition of requirements and risk identification & analysis processes provide the continuous remit for human resources management, training and development and risk management to adapt. research & innovation and organisational learning seek more efficient and effective response techniques and structures.

6.3 Redefining the processes for GEMA

Chapter 5 concluded that some processes from the original PCMM were identifiable components of an emergency management system. The analysis indicated that there was evidence of a select few PCMM processes in nearly all the data sets studied. The purpose of this section is to design and justify the processes that will form the basis of the maturity levels for the GEMA. Elements of the original PCMM processes will be adopted, in line with the conclusions from the data; however the analysis also indicated that significant changes in terminology and focus will be necessary.

6.3.1 Process streamlining –the Trident sequence

Primarily, the data analysis sought to prove whether the processes, assessed by PCMM as evidence of an organisation’s maturity, would also indicate the maturity of its EM system. Data was collected from plans, exercises and feedback sessions or interviews. Although some identical processes were found across the different data sets, each process appeared to have a different focus when it was observed in the planning, exercising or feedback stage.

Figure 6-2Trident assessment sequence

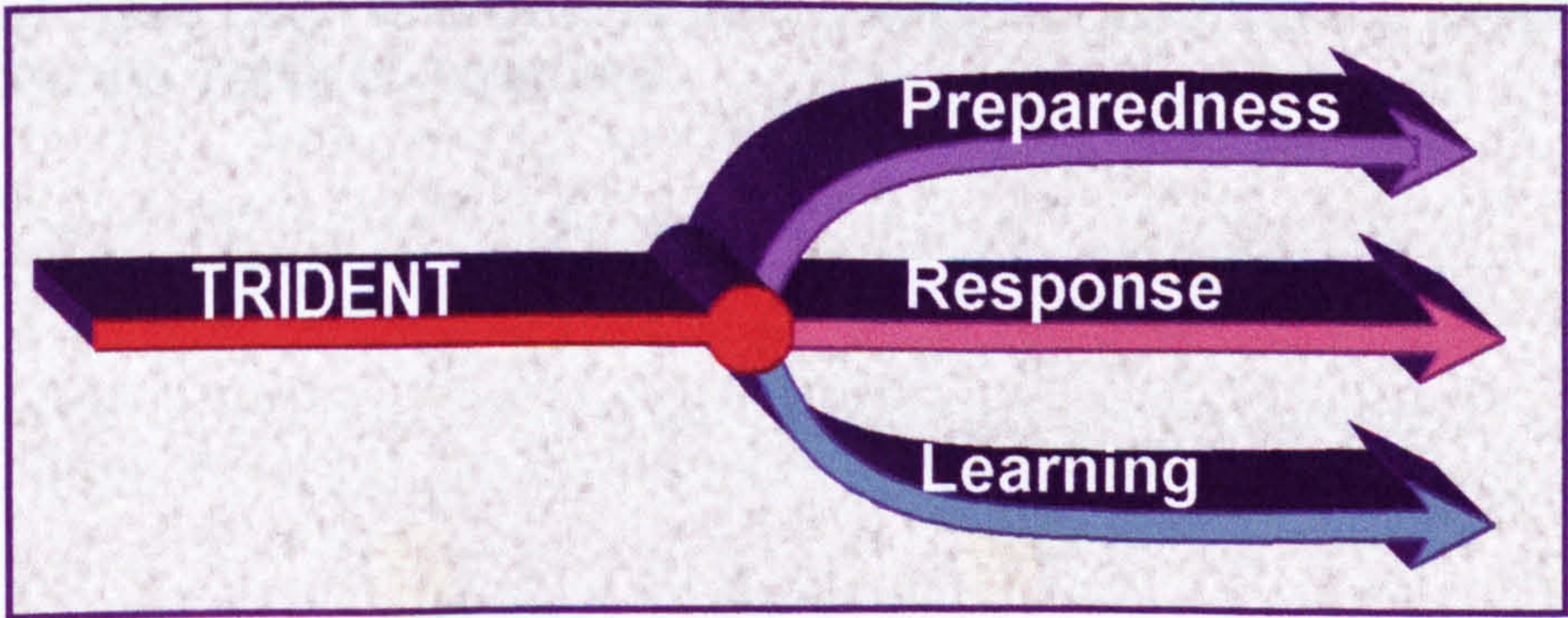


Figure 6-3 below compares three example processes at each of the three stages to illustrate this change in focus.

Figure 6-3 Process comparisons between stages of EM system

Focus→ ↓Process	Preparedness	Response	Learning
Staffing	Ensure sufficient suitable staff available to respond	Call-out procedures provide adequate staff	Staff problems recorded and system adjusted
Work Environment	Risk-based allocation of resources identified in plan	Facilities and resources in place to manage situation	Resources replenished and problems addressed
Training & development	Training to ensure all staff have necessary skills for roles	Exercises used as training tool to provide realism and test	Training reviewed in light of practice.

The focus of each process addresses three interlinked elements of the emergency management cycle in turn. This dissection of each process supports diagnosis of any problems, facilitating more accurate and directed improvement.

This ‘Trident Sequence’ breaks down the assessment into three manageable, linked sections, each measured by different means. The preparedness stage can be assessed by examination of documents, plans and interviews with the staff responsible. The Response phase can be assessed through the observation of an emergency exercise, and the learning phase can be evaluated through observation of the incident debriefing procedures and interviewing participants following an exercise. Although the three phases are sequential in an organisation, their assessment is attacked as a three-pronged approach, hence the Trident sequence label. This three-stage approach was particularly recommended by the Expert Validation Panel, and is discussed in Chapter 7.

The original PCMM used a similar concept called ‘areas of concern’ which were themes that linked the key process, as shown in Figure 6-4 . The processes have been abbreviated in this diagram, and the full meanings can be found in the Table of Acronyms.

Figure 6-4 Process ‘areas of concern’ from original PCMM

Focus→ ↓Level	Developing individual capability	Building workgroups & culture	Motivating & managing performance	Shaping the workforce
5	CCI		OPA	CWI
4	CBA, M	CI, EW	QPM	OCM
3	CD, CA	WGD & PC	CBP,	WFP
2	T & D	C & C	WE, PM, C	S

Adapted from (Curtis et al. 2001: 43)

In the original model, each process was specific to one level and a particular area of concern. For example, the diagram shows that the process of EW (Empowered Workforce) would only be expected to take place in an organisation at level 4 maturity, and is part of the ‘Building workgroups and culture’ area of concern. In the GEMA the same set of processes applies at each level of maturity. Each process is also divided into three focus areas of at each level. This three stage split has been labelled as the Trident sequence. Taking the process of staffing as an example, the EM system would be assessed in terms of how the staffing process is performed at each stage of the Trident sequence – in the plan, during the response and during the feedback and learning. Depending on the capability and maturity of the organisation in carrying out that process, it would be assessed as level 0,1,2,3 or 4.

The layout of the emergency management framework will be determined once the full set of processes has been defined in the next section. Definition of the processes for the new model was carried out by comparing aspects of the original model to the analysis of the data and incorporating concepts, ideas and requirements raised in the literature.

6.3.2 Origins of the new process set

As previously discussed in 6.1.1, the data indicated that some changes to the PCMM structure would be required to apply it to emergency management assessment.

The names of the processes were changed after a significant amount of research brainstorming with input from several different colleagues. It was important to ensure that the language of the framework was appropriate to engineers, emergency managers, regulators and any other stakeholders in the emergency management system that might not be familiar with the organisational management terminology preferred by the American designers of the original CMM.

There were also several changes to the design of the framework as a result of the data analysis. Two processes were changed into qualifying statements,

and two processes were removed from the framework, as there was no evidence that they contributed to emergency management capability.

The process of compensation was removed from the framework because there was no evidence from the sites, plans or interviews that remuneration for emergency duties was considered appropriate. Professionals who were employed full-time in an emergency response or planning role clearly should be paid according to their qualifications and experience, but that is considered separate (this will be discussed in Chapter 8, discussion) from the majority of emergency management staff who voluntarily agree to the duties in addition to their paid full-time position. There was also no indication from the literature that remuneration of duty emergency managers affected the capability of the organisation in any way.

The 'Workgroup Empowerment' process was also removed from the framework, as there were two exercise scenarios where operational teams were empowered to carry out tasks, and this transfer of control out of the ECC resulted in poor information flow and severe delay to the tasks. Empowerment is the transfer of official authority and the encouragement of initiative. It is important in emergency management that authority and responsibility remain with the coordinating body, but also necessary that initiative is encouraged throughout the system. For this reason, Workgroup Empowerment as a process was removed, and the encouragement of initiative is incorporated in the 'Research and Innovation' process, whilst authority to act is contained in the process qualifiers 'communication, coordination and integration'.

The diagram (Figure 6-5) on the following page illustrates how the new GEMA framework was designed using the data analysis and original CMM elements. Working from the top down, the original PCMM processes are shown in the white boxes. Those with purple borders are processes which have been identified in the emergency management data. Blue bordered processes were not identified in the data, but have been highlighted by the literature as important novel concepts which could enhance EM performance. These processes may not be visible when observing exercises or plans, as they are more strategic than operational or tactical in their nature.

These white process boxes are followed by a large red section which describes how the PCMM processes combine to create the new emergency management (EM) process in the solid red box below. Following this diagram, each of the eight new GEMA processes are described in detail. Figure 6-6 to Figure 6-13 show an individual chart for each process, giving a statement of process and definitions of why the processes should be performed in a particular way at each level, and why each stage of the Trident sequence is necessary.

Key relating to Figure 6-5

KEY	EM Framework process	Data-supported PCMM process	PCMM process
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Figure 6-5 Summary of GEMA process origins

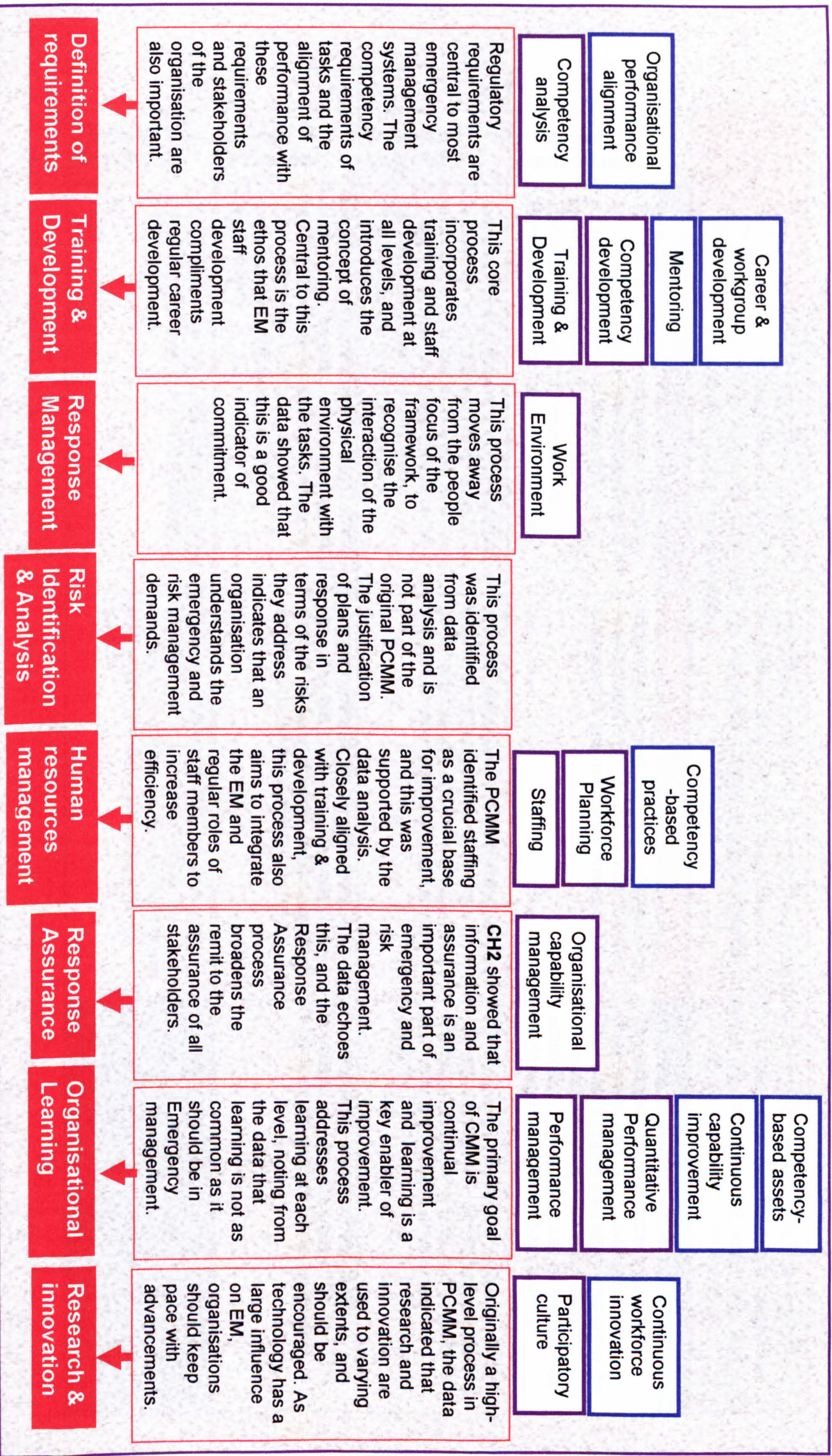


Figure 6-6 Process description for 'Definition of requirements'

Definition of requirements		The purpose of 'Definition of Requirements' is to ensure that an organisation has designed its emergency response to meet the regulations and other demands placed on it. This process enables the organisation to understand and comply with the necessary legal requirements for emergency management, and meet the expectation of its stakeholders.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	The plan embraces corporate responsibility and proactively addresses the concerns of the stakeholders. Continual liaison with stakeholders enables plan to adapt to meet changing demands and requirements. Participates in consultation with regulator.	Incident liaison and monitoring of stakeholder requirements is carried out in order to adapt the response and respond to arising needs.	Encourages input into learning from other stakeholders and non-standard sources. Organisation learns from other sites under the same regulatory regime. Contribution to emergency management can be learned from novel experiences and other incidents.
3	Measured & Integrated	Independent assessment of compliance and satisfaction with planning. Compliance is measured and recorded. The plan is integrated to meet the requirements of the legislation, environment and society. Procedures exist to measure targets.	Measurable targets exist for meeting response requirements. Targets are set through stakeholder liaison, and could include joint targets with other responding agencies.	All response parties are involved in learning process. Surveys are used to gather data how well requirements were met, and a report on performance in incident or exercise is produced.
2	Defined & Focussed	Regulations are understood and met. Plan clearly states the goals of the response and is based on the current regulatory framework. The organisation is focussed on full compliance with the regulations and requirements.	Requirements are clearly defined as protecting live, assets and the environment. Defined strategy for media, public, regulators and the organisation's own requirements.	The response is assessed against its objectives, and the adequacy of the plan is judged on the performance in the incident.
1	Functional & Repeatable	Plan and procedures are designed to only the essential requirements of the regulations and their legal duties.	Response is focussed on the health and safety of the personnel involved in the incident. A predetermined media release may exist, and a 'one size fits all' approach is taken.	Learning does not take place at level one for this process.

Figure 6-7 Process Description for 'Training and Development'

Training and Development		The purpose of the 'Training and Development' process is to use all possible means to provide individuals and teams with the knowledge and skills necessary to fulfil their roles. The process should also provide the opportunity for individuals to progress and develop in their emergency management roles alongside their regular careers.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	The structured development of individuals is linked to career progress in their regular role. Training and development work to ensure that competencies gained, benefit both regular and emergency management role. Training is continuous.	Teams equipped with same set of competencies are able to provide additional support during an incident. Knowledge gained during incident is recorded for future incorporation into training. Incidents and near-misses are recorded and re-used for training.	Training modules are developed in-house by experienced staff, in order to preserve and share the knowledge. Training and competency development are continual, and the level of competency across the organisation is continually improved.
3	Measured & Integrated	Experienced EM staff mentor junior members through a recorded, structured programme of skills transfer. Training progress is monitored and targets are set and recorded. Training is integrated, competency-based, assessed and refreshed accordingly.	Performance of teams is assessed during exercise or incident, against measurable targets. Assessment is recorded and used to structure future training.	The impact and efficiency of the training is monitored and training methods are adjusted accordingly. Records of team and individual competency levels are kept and training is used to maintain these levels. Interagency feedback on performance takes place.
2	Defined & Focussed	Individuals are selected and trained according to a matrix of skills necessary to carry out their role. Training is linked to response requirements outlined in the plan. Plan makes provision for records to be kept during an incident.	Competencies are defined for each role, and records are maintained. Training is focussed on these competencies. Teams are trained and practice together to encourage cohesion. Performance is recorded in exercises and incidents.	Training and development is structured to meet the needs of the response, and there is some feedback from the recipients of the training regarding its use and value. Feedback is recorded and used to structure future training.
1	Functional & Repeatable	Individuals are trained to complete the specific tasks assigned to them in the emergency plan. Type of training is documented in plan.	Basic exercising of roles aims to test individual skill level. The goal is to train and practice rather than develop skills.	Individual performance feedback is given, however development is not formally recorded.

Figure 6-8 Process description for 'Response Management'

Response Management		The purpose of 'Response Management' is to establish and continually ensure that the physical environment, resources and facilities are in place to support the individuals and teams in fulfilling their emergency management roles safely and efficiently.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	The organisation shows commitment to flexible resource allocation and procurement. The plan permits use and acquisition of resources where they are most likely to be needed by the response or in flexible planning to address changing risk.	System in place to prioritise the resources available for response and to predict changing requirements during an incident.	Continual revision of facilities and equipment is carried out to ensure that response capability is maximised. Actively seeking alternative technology to aid a safe and efficient response, through the Research and Innovation process.
3	Measured & Integrated	Organisation commits quantitative resource targets to emergency management. Resources are available for sharing among response agencies. Plan facilitates sharing and transfer of resources between agencies and areas.	Resource sharing and integration is facilitated in the response, personnel are comfortable in facilitating the sharing of resources.	Feedback on response facilities from all agencies, including discussion of efficient use of equipment and facilities. Quantitative measures of resources and use are made to improve future use and procurement.
2	Defined & Focussed	Resource allocation is defined on basis of the scenario envelope, based on understanding of site risk. Back-up facilities and resources are available should they be required.	Resources are deployed to address tasks, and are prioritised as required. Facilities are equipped to deal with the perceived worst credible incident. Information management facilities are in place and understood	Logs and records available for analysis. Procedures in place to analyse response and distil lessons learned. Resource issues focussed within organisation.
1	Functional & Repeatable	Procedures and plan are in place and sufficient resources and facilities are available to deal with only the most likely incidents.	Basic facilities to manage fire and medical situations and a functioning ECC are available. Communications facilities are in place and used.	Learning does not take place at Level 1 for this process.

Figure 6-9Process Description for 'Risk Identification and Analysis'

Risk Identification & analysis		The purpose of 'Risk Identification and Analysis' is to firmly engage a risk-based approach to emergency management at all levels of planning and response. The process provides the foundation for accurate and comprehensive planning and assurance of adequacy.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	Integrated risk and safety policy aimed at continual identification, reporting and assessment.	The response information continually updates the understanding of the situation and can adapt to any internal or external changes.	Continually assessing the accuracy and efficiency of the risk identification and analysis. Organisation considers advances in the field and externally gained knowledge.
3	Measured & Integrated	Risks are identified, assessed and measured and are prioritised as the basis for the emergency plan. An all-hazards approach to risk and emergency management is adopted	Risk to personnel, the environment and probable impact on the organisation's business are measured and assessed during an incident	Quantitative comparisons between actions taken and risk. Analysis of possible outcomes. Risks are prioritised further in line with new knowledge.
2	Defined & Focussed	Risks have been identified and the worst case scenario or worst credible event is used as the upper limits for the emergency planning.	Operational risk assessment for medical and fire events. Priorities are defined and some records are kept.	Team level awareness of risk issues in response and how they can be addressed and remedied. Team identification of competency and skill problems, and additional risk this might cause.
1	Functional & Repeatable	The plan shows an awareness of the hazards, but little appreciation of risk concepts.	The response mainly involves a safety-based hazard assessment.	Learning does not take place at level 1 for this process.

Figure 6-10Process description for 'Human Resources Management'

Human Resources Management		The purpose of the 'Human Resources Management' process is to promote an accountable and sustainable attitude to HR for emergency management, which will increase the organisation's capacity to deal with any emergency situation. As the personnel are responsible for the organisation's response, they must be recognised as a valuable asset.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	Staffing and HR policy integrates emergency management competencies with regular work, to ensure continuous practice and enhancement of skills. Integrated management of regular and emergency management roles.	Appointed person to manage HR issues in the response, including monitoring of staff well-being and adapting HR resource issues.	Structured feedback on strategic staff requirements. Integrated learning and HR development, optimising staff recruitment and training policy.
3	Measured & Integrated	Adequacy of team performance is monitored and targets are set and measured. Roles and responsibilities are coordinated with other responding agencies. Response needs are measured and staff is calculated accordingly.	Assessment of team and individual capability takes place. Integrated approach to staffing across teams and agencies during incident, with facilities for support and back-up.	Incident responders show awareness and understanding of all aspects of the incident, including multi-agency response. A feedback report highlighting positive and negative issues of each role, is produced following any incident.
2	Defined & Focussed	Teams are structured to respond to risk in most efficient and safe manner. Plan has options to adjust staffing requirement according to the incident risk.	Roles and responsibilities are coordinated in the incident. Staff is aware of their role and fulfil their responsibilities. There is adequate staff to manage and operate the response.	Staff are able to discuss their roles and tasks in an incident through the feedback meeting. Team performance is discussed within team, and structure can be changed to cope better next time.
1	Functional & Repeatable	There is sufficient staff detailed in the plan to respond adequately to incidents. Plan identifies staff and their contact details, with instructions for call-out.	Effective call-out to response by majority of staff with emergency role. Majority of roles can be covered in a response.	Learning does not take place at level one for this process.

Figure 6-11 Process description for 'Response Assurance'

Response Assurance		The purpose of 'Response Assurance' is to inform and satisfy all stakeholders that the EM capability of the organisation is adequate to deal with any incident that might reasonably occur, and protect them from loss or harm.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	Continual information exchange with stakeholders on the emergency management capability of the organisation. Strong relationships of mutual trust and respect exist, alongside a commitment to preparedness.	Targeted strategic assurance of response is integrated with information management pre- and post-incident. Continuous assurance monitoring.	Any incident is analysed by a committee, who produce action plans to implement lessons. The process then involves the testing of the new measures through further exercises, which are reported to the committee leading to continuous improvement.
3	Measured & Integrated	Documents provide proof that organisation has the capability to deal with any incident. The distribution and quality of the documents is surveyed and measured in terms of their use and value to recipients, and their updating.	Integrated assurance approach with other agencies in the response. The coverage and adequacy of the assurance given is monitored during a response, joint statements and coordination of media efforts.	A report of any incident is published, and agencies integrate their targets. Feedback from stakeholders and peers also influences any further measures and improvement of plans and procedures.
2	Defined & Focussed	The plan provides assurance to wider stakeholder groups that risk-based concerns can be adequately managed by the organisation. Specific information distribution also takes place, and stakeholders are defined.	Regular information regarding the progress of the response is provided to the organisation internally, and through the media organs to the wider public.	An internal report on the incident is produced for the staff and regulator. Information may also be provided to the public on an informal basis, for example through a media article or report.
1	Functional & Repeatable	The plan provides the main source of assurance that basic response measures are in place.	Information is provided to the onsite population through alarms or PA messages.	The incident is discussed internally, and any feedback is shared with participants and the staff present.

Figure 6-12 Process description for 'Organisational Learning

Organisational Learning		The purpose of the 'Organisational Learning' process is to capture and retain the knowledge gained from emergencies to promote the improvement of emergency management capability, and enhance future incident prevention, response and management.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	The emergency plan is focussed on learning at every stage and provides structure and methods for a learning response. A structure is in place to recognise and exploit learning opportunities.	Analysis of data during response allows more rapid adaptation of the response to meet the requirements of the incident. Closely tied with Risk Assessment and Requirements Definition processes at this level.	Knowledge capture net is extended to other organisations and fields, and advances in other areas are put to use in improving capability.
3	Measured & Integrated	Quantitative performance management. Targets are set for ensuring that response is recorded at all levels, to facilitate maximum potential knowledge gathering from any incident.	Data is gathered during the response to enable numerical targets to be monitored and the knowledge to be captured from all responding agencies. Roles are defined and facilities are in place to allow this.	Integrated knowledge sharing across org and between agencies. Numerical targets are analysed and adjusted. There is comparison across involved agencies and teams, which is encouraged and facilitated.
2	Defined & Focussed	Plan contains instructions on how to record performance, templates and checklists to aid standardised recording.	Exercises and incidents are used as learning opportunities. Protocol for recording and logging information during incident, performance is recorded at individual and team level. Knowledge capture is a defined goal.	Internal knowledge sharing. Individuals within teams share the knowledge gained in the incident.
1	Functional & Repeatable	Plan updates and changes are recorded, and the documents contain mechanisms for regular maintenance.	Data shows that low maturity organisations do not learn from incident response, and the same mistakes can be repeated in later incidents.	Data shows that low maturity organisations do not learn from incident response, and the same mistakes can be repeated in later incidents.

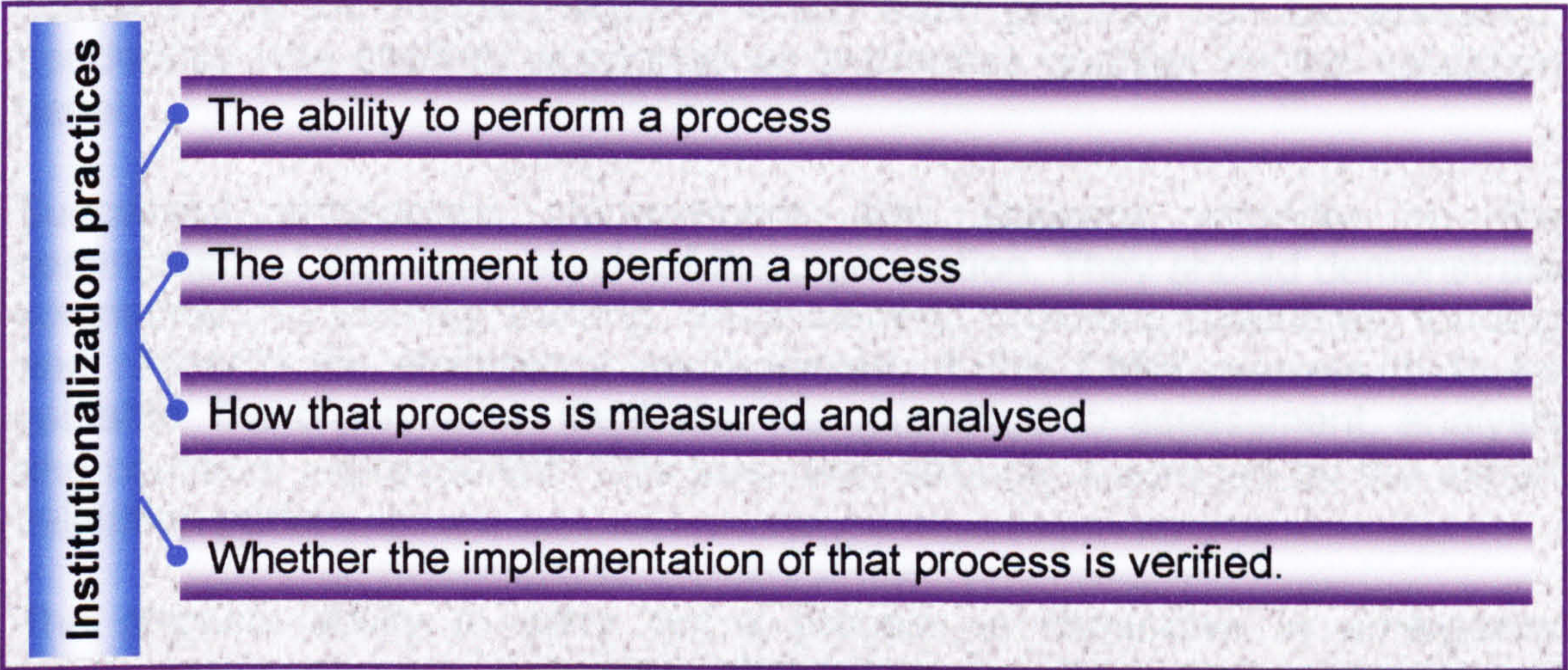
Figure 6-13 Process Description for 'Research & Innovation'

Research & Innovation		The purpose of 'Research and Innovation' is to devise more effective and efficient emergency response methods and systems through the commissioning of research and investigation and controlled experimentation with novel concepts and ideas.		
		PREPAREDNESS	RESPONSE	LEARNING
4	Adaptive & Optimising	Plan contains mechanisms to encourage innovative practice in teams during an incident. Organisation displays an innovative intent through its documents. Research is carried out into emergency planning methods and improving preparedness.	Monitors the response for innovation opportunities. Analysis of response records over time provides strategic guidance to research policy.	Sharing and publishing innovation and research product throughout sector and organisation and response agencies. Using knowledge from others to improve own practices and response.
3	Measured & Integrated	Joint research is carried out with other agencies, and the hazards and risks faced by the organisation have been researched. Research is an annual budgeted activity.	Measurement of stress, personnel issues and timing of response to aid future development of methods. Innovation encouraged in the response, and control measures in place to make it work. Recording of innovation to instil as good practice	All agencies contribute new ideas to improve response on the basis of incident experience. Analysis of the response takes place, to determine novel concepts for further development and research.
2	Defined & Focussed	Internal research into own hazards and plant issues. Practically based research at this level.	The data indicates that this process is not carried out in a sustainable manner at lower maturity levels.	Site contributes to lessons learned, and novel methods are encouraged. Individuals contribute in unstructured framework of collaboration.
1	Functional & Repeatable	The data indicates that this process is not carried out in a sustainable manner at lower maturity levels.	The data indicates that this process is not carried out in a sustainable manner at lower maturity levels. ← →	The data indicates that this process is not carried out in a sustainable manner at lower maturity levels.

6.3.3 Appropriate process assessment indicators

To assess the extent to which each process is implemented the original PCMM used a set of four qualities called ‘institutionalization practices’. They are show in Figure 6-14below.

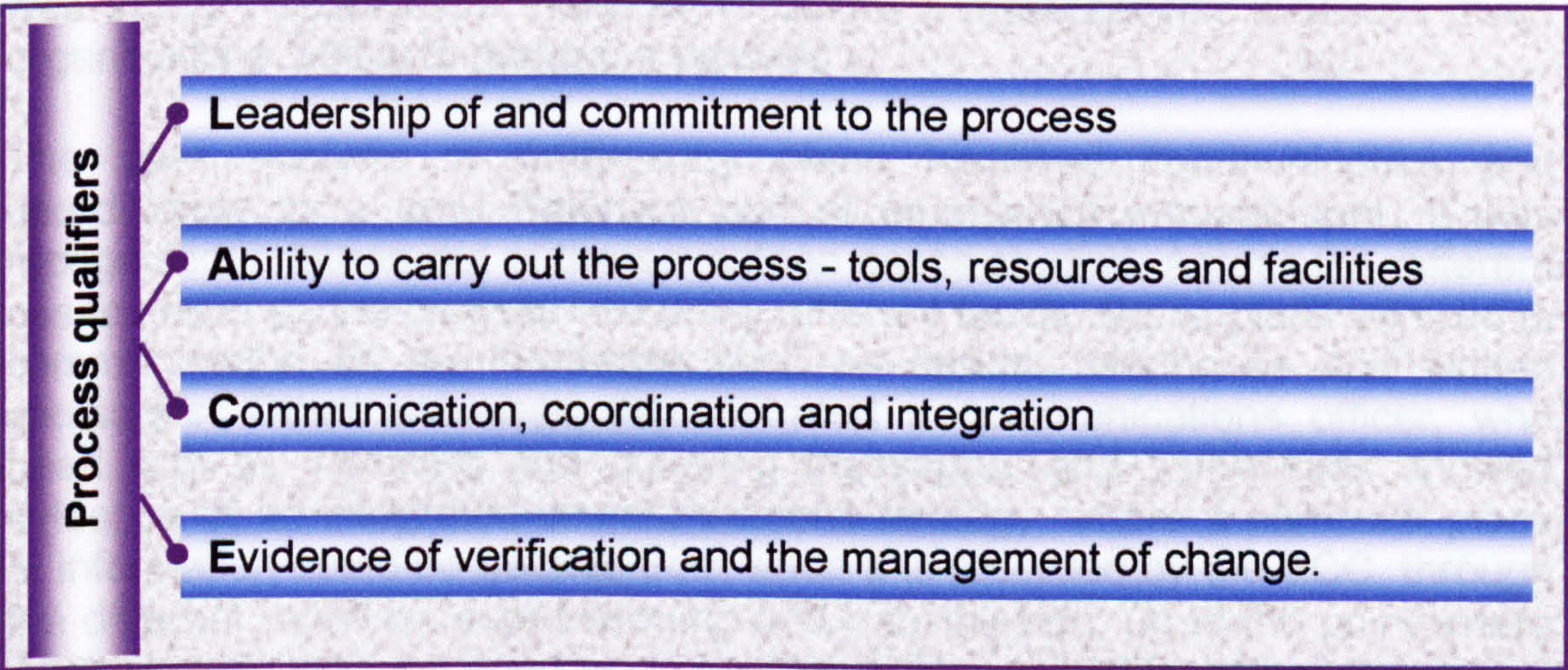
Figure 6-14 PCMM Institutionalization practices



Based on (Curtis et al. 2001: 55)

These process qualities are necessarily vague in order to account for the variations that occur in different processes across a whole organisation, as mentioned in 6.1.1. Generally, an emergency management system is smaller and has less variation so the assessment qualities can afford to be more specific. The process qualities for the new GEMA have been defined from the information gathered in data analysis, and will now be described.

Figure 6-15 Emergency management process qualities



Each process will be assessed using the four qualities shown in the table, across the five levels and three stages of the Trident sequence.

The literature highlighted the ideological divide between the traditional ‘command and control’ approach to emergency management and the more contemporary attitudes of ‘continuity and cooperation’ championed by Dynes

(1990) and the Incident Command System, described by Alexander (2002b). Both schools of thought require that there is some form of leadership of the response, from operational leadership and decision making through to strategic and organisational leadership. This hypothesis has been supported by evidence from the data analysis. Leadership was considered to be more than a process, rather a wider quality which is essential to the stability and success of every process. For this reason, leadership and commitment are combined as an indicator against which each process can be assessed. Leadership was strongly supported as a process qualifier by the validation panel.

Successful emergency management also depends strongly on the commitment of the senior levels of the organisation. They should demonstrate commitment to staffing, training, advancement, providing resources, funding and research for emergency management. If the CMM process is to be valuable, the organisation must also be committed to assessment, analysis and continual improvement. This point was strongly supported by the expert validation panel

The physical ability to carry out a process is imperative in emergency management, as some processes depend on specific tools, equipment and facilities. Lives and assets can depend on equipment being serviceable and in the correct location when required, and so the organisation should be assessed not only on the fact that they have recognised the need for a process and planned for it, but also that they have the correct equipment ready to implement the tasks.

Equipment failure or deficiency did not cause any major problems in the exercises analysed, however the lack of tools and mechanisms to assess and evaluate exercises was a weakness of nearly all the organisations studied. It was thought appropriate therefore to define a more specific measure of an organisations 'ability to perform a process'.

The data analysis of emergency plans identified communication and coordination as a very important part of emergency management. It was recognised in fifteen out of the seventeen cases studied. Across the different cases however, the process had many different facets. Some plans referred to communication as the hardware such as radios, telephones and written messages. Other exercises demonstrated a communications officer, who dealt with all incoming and outgoing messages, and some sites showed evidence of an integrated communications strategy, where a particular piece of information could be tracked from when it is recorded by the ECC, through the different forms of record keeping and transmission, up to the point where the task has been actioned and concluded. The validation panel stated that communication was a vital part of each process, so should be included as a process qualifier.

In order to encourage organisations to take a holistic approach to this crucial aspect of emergency management, communications and coordination has been designated as one of the qualities by which all the processes are

assessed. The coordinated sharing and recording of information is central to all processes, and as such, they should be assessed on that quality. This process qualifier also incorporates the aims of improving efficiency and agility of interdependent work, which is dependent on good communications and coordination. Curtis et al. (2001: 37) paraphrase the aspiration of this process qualifier as a "seamless process-based interaction among individuals...".

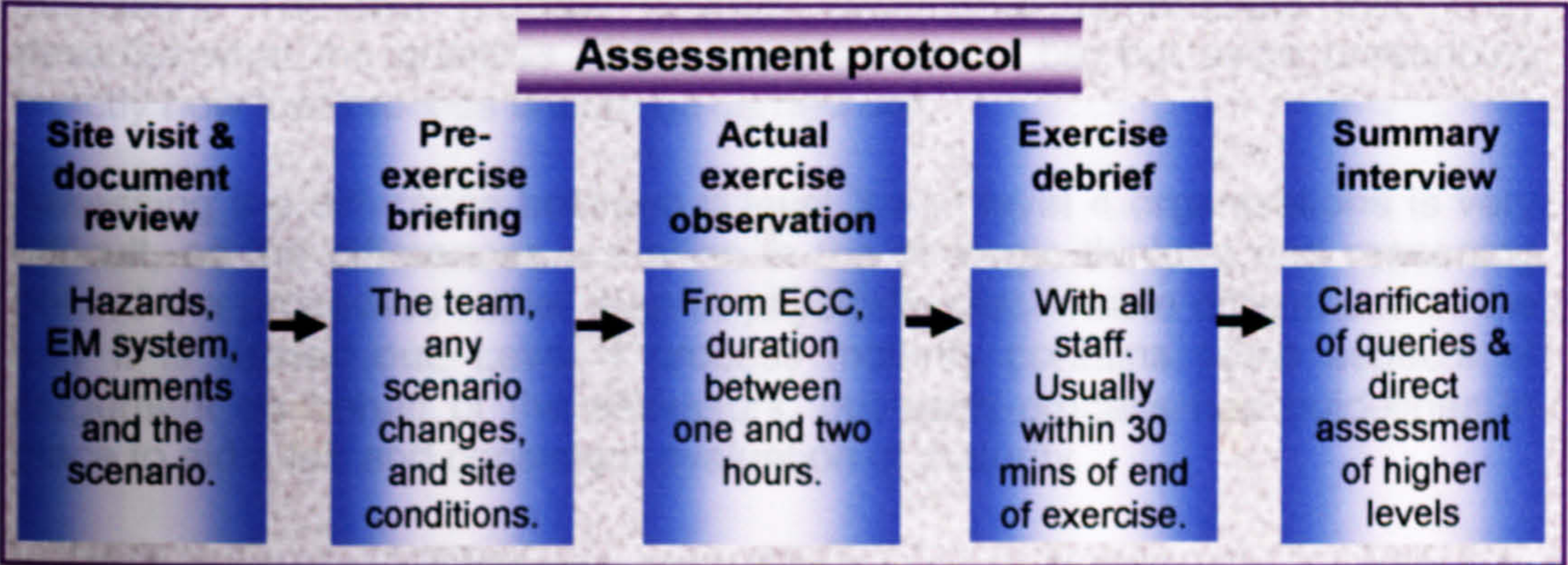
The final process assessment indicator acknowledges the importance of addressing change. Several of the organisations in the study had undergone a recent major change, and there were some differences in how the emergency management system had responded to that change. Change can also happen during a response, if the weather conditions change, EMT members fail to respond to the call-out or there is a utilities loss. Changes in shift pattern, site lay-out, corporate structure, plant operations or the external environment can also have linked effects on the emergency plan and response capability, so managing change is an important concept to apply to all processes. Verification is an important aspect of all processes, as it can prove that the organisation has sought to confirm that it is adequately address its risks. Verification of a process can be found by examining the aspects of the process in two or more of the Trident stages, or from an external verification source such as compliance with a regulation, inspection by a third party or verification by an external body.

level 4

6.3.4 Changes to the assessment protocol

The original assessment method used by the PCMM assessors demanded a large commitment of resources. Such resources are not available in EM assessment, and so a different technique would be required. The data analysis showed that significant information about an emergency management system can be gleaned by examining their emergency plan, visiting the site and observing an exercise and the aftermath. The data also indicated however, that these methods gave good coverage of the lower maturity aspects, but poorer indication of any level four or five standard performance. To address this shortcoming, it was suggested that a final interview should be carried out, to consolidate and expand on information from the practical observation and plan review. The interview can then specifically address any processes which are missing from the data, and any higher level processes which may be difficult to identify by indirect means. The whole assessment protocol is therefore an extension of the data collection method outlined earlier in Figure 4.4, and shown below.

Figure 6-16 Assessment protocol for emergency management framework



Techniques and guidelines for assessment will be discussed later in this chapter and tested in Chapter 7, Application of the model.

6.4 The Assessment Protocol

This chapter has described how an Emergency Management assessment and improvement framework has been constructed from data analysis and use of established techniques from other fields. The final section will describe how the framework should be used to carry out an actual assessment of an organisation's emergency management capability and maturity.

There are some background considerations however, which should be understood by the assessor and the organisation before making an assessment. The primary goal of a CMM type assessment is to facilitate continuous improvement in an organisation. CMM is not simply a point-scoring and grading tool to give a measure of the site's achievement. An effective CMM assessment requires that the organisation involved is committed to learning, development and improvement. In a similar fashion, the maturity levels do not have an adequacy point, where the level of maturity is considered 'good enough' and the organisation can stagnate and be content. As the framework is strongly related to the individual risks on the site, the organisation should be aware that the only level which indicates that they are dealing with that risk in the most efficient, effective and sustainable manner, is level 4.

The CMM processes and improvement guidance given by the model, however, is not prescriptive. Processes and process-qualifying statements detail *why* the organisation should carry out a particular activity or process to be considered as that level of maturity, but not *how* they should do it. The main reason for this focus on principles rather than practice is the variation between organisations and how they function and operate. It is far better to give the reason for carrying out a certain process, and allow the organisation to deal with the resources and decide the method of carrying it out, than prescribe precise sequences of events that should take place. The former results in a generic and appropriate framework, whereas the latter would create an organisation or even site-specific assessment tool, which would have to be adapted and changed for every different application.

In a similar manner, the GEMA does not use quantitative scoring to measure the processes. Especially in the higher maturity levels, definitions become less tangible and leave more scope for the opinions and judgement of the assessors. The four process qualifier statements demonstrate this. They describe what the qualities of the process should be, but avoid prescribing exactly how that process should be carried out.

Assessing the difference between a level 3 and level 4 organisations is very difficult, as the differences are often in the strategic thinking and reasoning behind the processes rather than in physically discernable differences in the way it is carried out. Level 4 process maturity contains some aspects of judgement on behalf of the assessors, but each process has guidelines in place to aid a fair and consistent evaluation of maturity.

6.4.1 Practical assessment guidance

Some skill and experience is required actually to observe an emergency exercise, review a document set and conduct interviews to obtain evidence of an organisation's maturity. Some practical guidance notes for exercise observation and plan review and interviewing have also been prepared and are contained in the Appendices (10-4).

The literature suggested a strive to improve the professional accountability of the emergency management field in the UK. In addition to this, the specialist nature of the subject suggests however that the assessment must be carried out by someone with a professional qualification or high level of experience in emergency management. The guidance notes are intended to supplement professional knowledge rather than instruct a novice to conduct an assessment. Guidance through the literature is available on techniques for observation of systems and people at work, the professional and accountable conduct of interviews and notes from the CMM literature are available to give guidance towards assessing maturity and capability related processes in organisations. The following section will describe how each stage of the EM system can be assessed using the GEMA.

6.4.2 Conducting an assessment – the Trident Sequence

The simplification of the emergency management system into a three stage 'Trident sequence' was undertaken in this research for several reasons. Primarily it gives organisations a simplified overview of a very complex area of their work. It is easier to ask that they visualise the actions taken before, during and after an incident rather than attempting to tackle the whole EM system at once.

It also divides each process into three parts, which focuses more succinctly on what that process means at each stage of the sequence. Finally, the Trident Sequence provides three different methods of assessing the organisation's maturity and capability. Preparation capability is assessed through examining documents, plans and the site itself. Response capability is assessed by observing the emergency management team carrying out an emergency simulation or exercise, and learning capability is judged by observing the exercise, feedback sessions and conducting additional interviews if necessary. Assessment for each stage of the Trident sequence will now be described.

6.4.2.1 Assessing Preparedness

Emergency preparedness is assessed by examining the emergency plans and associated documents. The plans are examined for proof that the organisation carries out the eight key processes (Fig. 6-5), and evidence of performance to indicate their maturity level. To assess the preparedness aspects of T&D, HRM and RM processes, it is necessary to tour the emergency management facilities, and seek information from members of the staff that are regularly involved in emergency management. In order to confirm that Risk Assessment has been considered and planned for, it may also be necessary to interview

different stakeholders, providing that representatives are available and willing to participate.

The original CMM assessment found it useful to prepare an organisation for their forthcoming assessment. This involved meeting the members of staff who played key roles in the areas of interest, in this case the Emergency Planners and Emergency Managers, and discussing the assessment with them in some detail. The site would then be presented with the list of process requirements, and the documents which may contain evidence. They would be invited to examine their own document set and highlight any evidence of the processes. This information would be used as a guide by the assessors, who would also examine the document set. This task was also useful because it ensured, at least for the duration of the assessment, that the organisation's representatives were familiar with their own documents and procedures. This is a useful technique if the organisation is fully committed to the assessment process.

6.4.2.2 *Assessing Response*

The response stage of the Trident sequence is assessed by the observation and analysis of an emergency simulation. The response is assessed to establish to what extent the organisation is carrying out the eight key processes. It is of great importance that observation of emergency exercises is carried out in a professional manner, using recognised protocols and techniques. The outcome of the observation will be affected if the observer does not adhere to certain guidelines and carry out vital preparation and research before the exercise takes place. Details of these techniques are discussed briefly in 4-9, the Methodology.

It is recommended (Wickens & Hollands, 2000) that observers should undergo some basic training in the psychological methodology of this type of research before carrying out observations in real scenarios. Whilst applauding recommendations for a professional, accountable and thorough assessment, it is the opinion of this researcher that as long as the observer is professional, meticulous and has carried out all the research and preparatory measures recommended, the observation will provide valid data and have no adverse effect on the participants.

A response assessment issue worthy of further explanation concerns exposure to the site and research into the organisation and their response. In order fully to appreciate and understand any emergency scenario or exercise, it is essential that the observer have prior exposure to the site and its emergency management system. Although there has been some recent homogeneity in the emergency procedures of UK MAH sites to comply with COMAH 1999, there are still vast differences between the sites. Such disparities include terminology, process chemicals and procedures, EMT structure and functioning, exercise style and design, ECC layout and use and interrelation with other agencies. Only with prior knowledge of, and exposure to the site will these unique facets of the exercise be fully appreciated by the assessor.

It has been a criticism by previous researchers in this field (Carthey 1998; Lyons 2002), that observation of emergency exercises is potentially a very useful tool, if the researcher could have control over the content, scenario and management of the exercise. The scenario could then be designed and conducted using consistent research methods, as opposed to the unique methods of scenario design used by different organisations. It could also be engineered to test elements of uncertainty discovered in the preparedness assessment, and custom-built to embrace aspects of each key process to provide an inclusive overview of the emergency management system. Resource limitations, mentioned in 6.1.1 and the complexities of scenario design are two strong reasons why there was limited involvement of a researcher, or assessor, in scenario design and management. A full discussion of this issue is presented in Chapter 8, Discussion. However, it is important to state at this point that if there is a level of flexibility in the scenario, the assessors should make their best effort to contribute in such a way as to test the responders and provide them with opportunities to clarify or confirm any uncertainties or issues that arose in the Preparedness assessment.

Any contribution to scenario design by assessors should always be in full consultation with the exercise manager. It should make best use of their knowledge and experience. Scenario design is a specialist subject and there is limited guidance from the literature. This point that will be further discussed in Chapter 8, Discussion.

6.4.2.3 *Assessing Learning*

The capability of an organisation to learn from problems and mistakes in the emergency management system can be assessed using the eight key processes. Learning is assessed by observing an emergency exercise and the feedback sessions that follow it. Assessors might also find it necessary to supplement this data by interviewing members of the emergency management team. Important aspects of the interview technique and method are described briefly in the Appendices, 10-4.

CMM focuses particularly on learning and improvement as part of every maturity level and every process. It is therefore important to consider learning as an integral part of the system, rather than being only contained within the OL process. Learning was made the third stage of the Trident sequence because the literature and data showed that there was a distinct lack of techniques and methods of learning within the UK emergency management sector. It conveys the message that learning is equally as important as preparation and response when managing emergencies and risk. This also realistically reflects the emphasis placed on learning and continuous improvement by modern management theory, including CMM. It is important to establish learning as an element of each process. Measures can then be included in the planning and response which will ensure that focussed and consistent data recording measures are in place to facilitate subsequent feedback and learning.

6.5 Presenting the GEMA

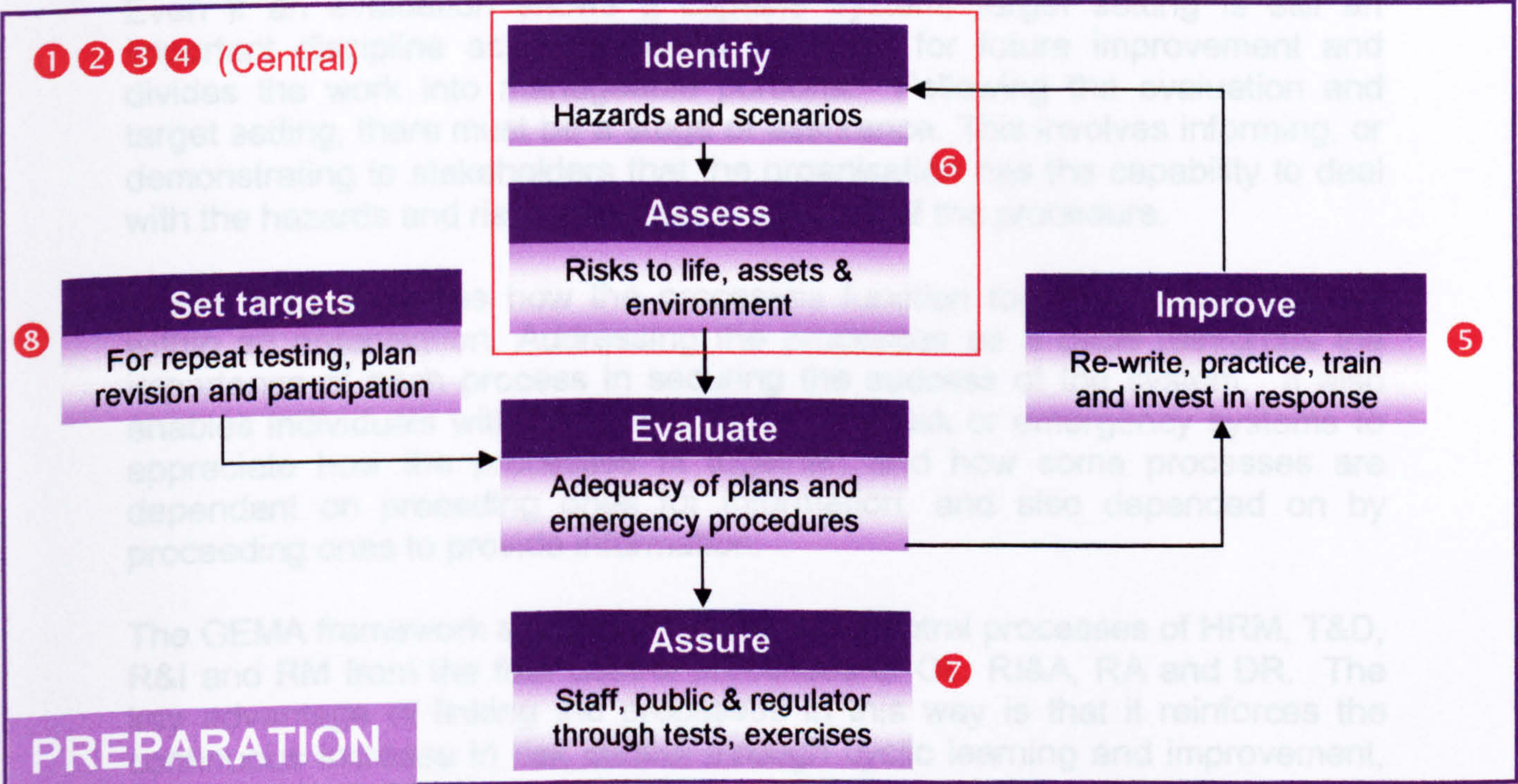
This chapter has shown how a framework has been designed to assess the capability and maturity of emergency management systems. The final section will summarise how the parts of the assessment and improvement framework fit together, and how the assessment should be carried out in an organisation.

6.5.1 Relating the processes to the EM System

Up to this point, the emergency management system has been summarised as eight key processes, performed differently at three consecutive stages of Preparedness, Response and Learning sequence. This section shows how the processes relate to each other. As mentioned earlier, the processes become more closely interlinked as the organisation becomes more mature, and so an understanding of the process relationships is vital for the appreciation of higher level maturity assessment.

It is important to note at this stage that the emergency management processes are divided into two groups. There are those which are part of an organisation's *central functions*, and there are those which enable the organisation to begin to *control* risk. The *central* and *control* processes and their interaction are illustrated in Figure 6-17 below.

Figure 6-17 Central and Control process diagram



KP1	Human resources management
KP2	Training and development
KP3	Research and innovation
KP4	Response management
KP5	Organisational learning
KP6	Risk Identification and analysis
KP7	Response assurance
KP8	Definition of requirements

KP 1-4 are the **central** processes, and 5-8 are risk **control** processes.

The diagram (Figure 6-18) begins with identification and assessment, which establishes what the organisation might have to deal with, and assesses how dangerous it could be. This is followed by an evaluation of how the organisation could cope with an incident, in its current state of preparedness. This evaluation is followed by improvement, which considers what improvement or learning is necessary if the evaluation exposes deficiencies. Improvement and learning is never completed, as once it has taken place, the organisation must reassess and identify any further hazards or risks resulting from the changes to the system, and evaluate their capability once again.

Even if an evaluation shows a capable system, target setting is still an important discipline as it outlines a schedule for future improvement and divides the work into manageable portions. Following the evaluation and target setting, there must be a stage of assurance. This involves informing, or demonstrating to stakeholders that the organisation has the capability to deal with the hazards and risks identified at the start of the procedure.

Figure 6-18 illustrates how the processes function together to **control** risk within an organisation. Addressing the processes as a cycle reinforces the importance of each process in securing the success of the system. It also enables individuals with little understanding of risk or emergency systems to appreciate how the processes fit together, and how some processes are dependant on preceding ones for information, and also depended on by proceeding ones to provide information.

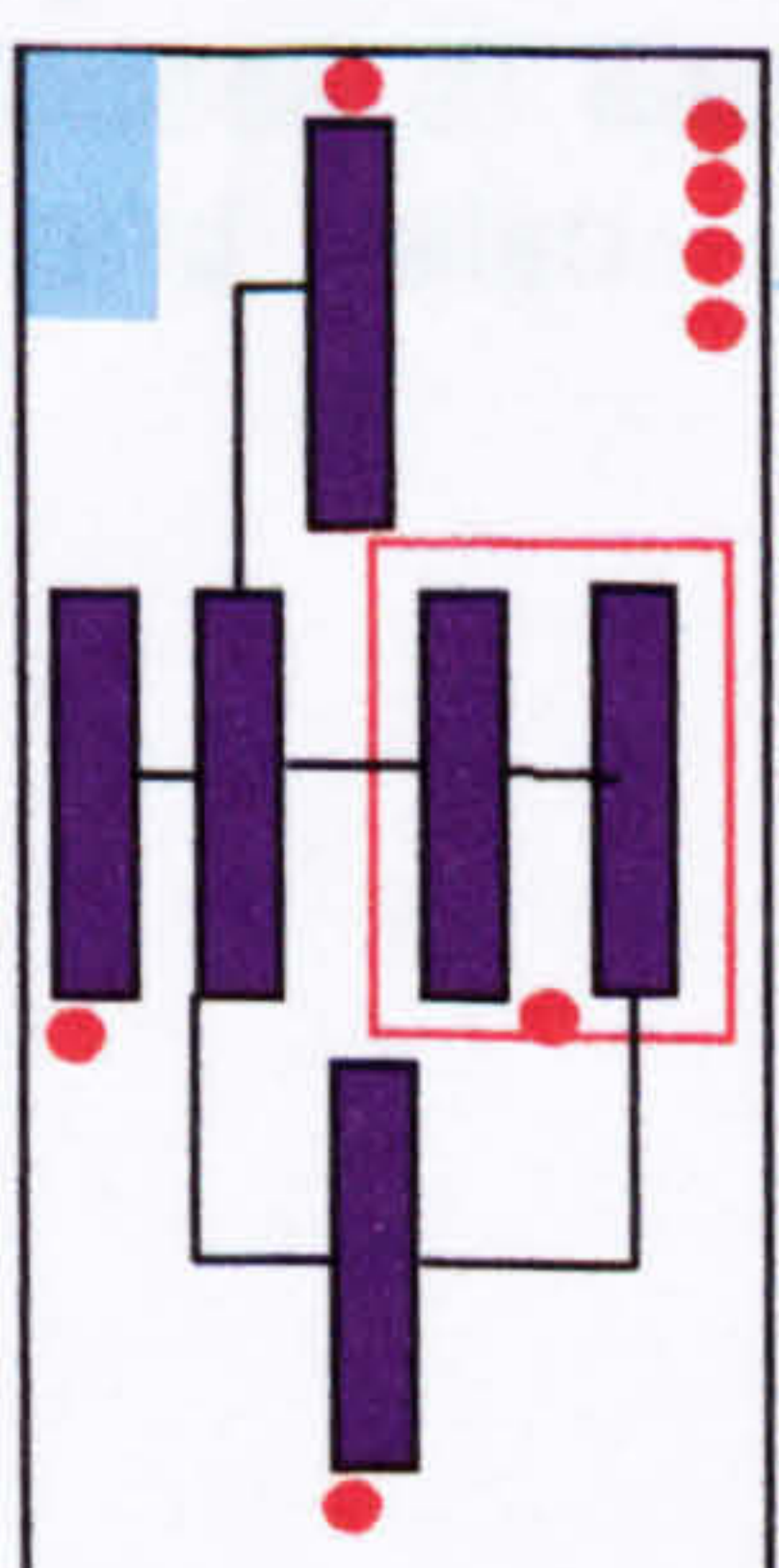
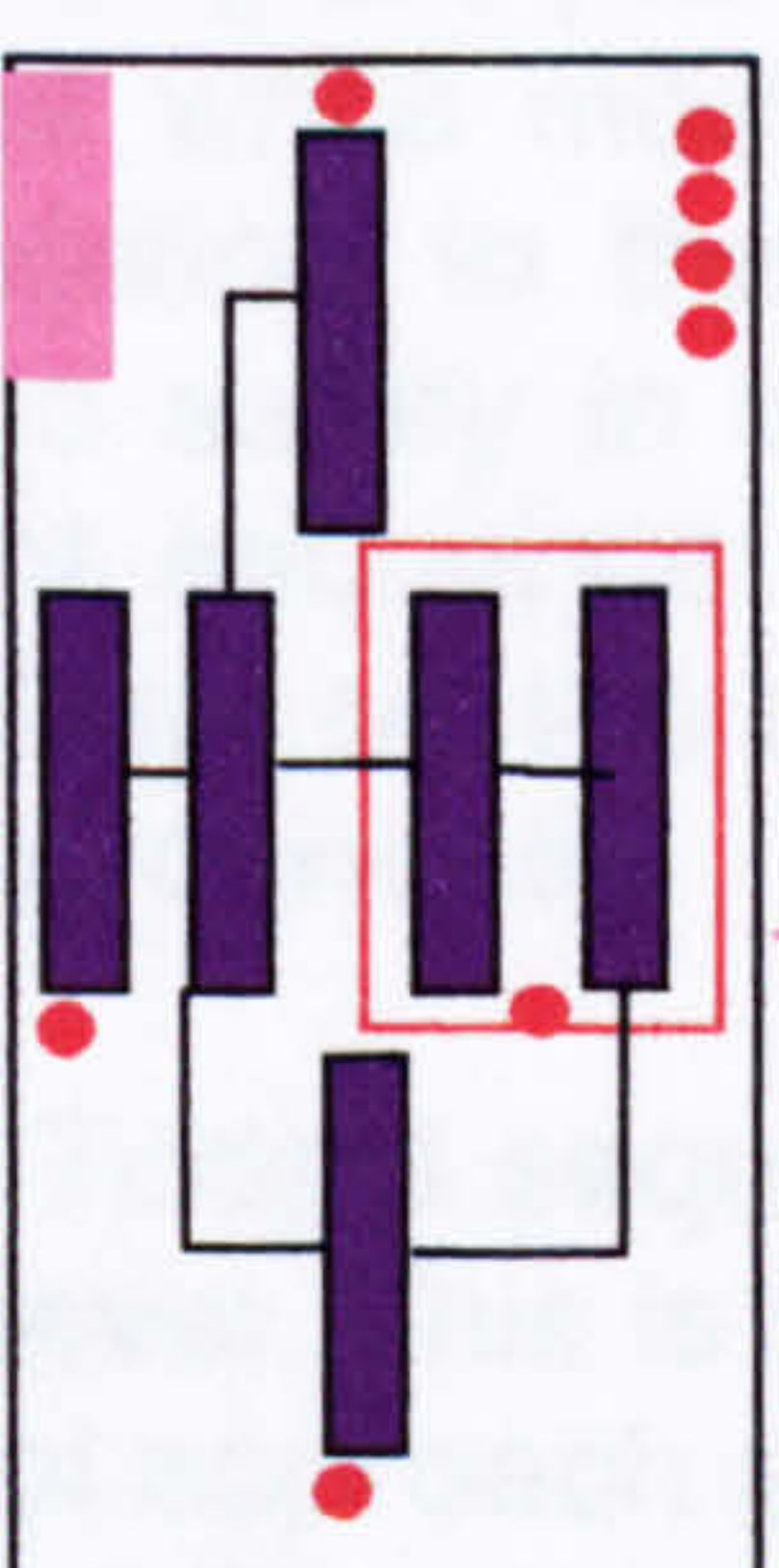
The GEMA framework separates out the four central processes of HRM, T&D, R&I and RM from the four control processes of OL, RI&A, RA and DR. The key advantage of linking the processes in this way is that it reinforces the continuous increase in risk control through cyclic learning and improvement, and the concept that processes have a provider-client type relationship with respect to information provision.

As described previously, the Trident sequence reflects the three prongs of attack that make up an emergency management system. The cycle of preparation, response and learning helps focus the process efforts, and provides a clear target for the assessment framework. The assessment should gather evidence on how each process is performed at each of these stages in the system.

Earlier paragraphs in this chapter also emphasised the need to create an assessment technique which was easily understood by engineers, managers, inspectors and the plethora of stakeholders in UK MAHI. A single side diagram that can explain the processes on which the EM system will be assessed and how the assessment will take place is a major asset in simplifying a potentially complex model. The following page shows a diagram of the full model and how the parts interact in an assessment. Following the diagram is an explanation of the full model.

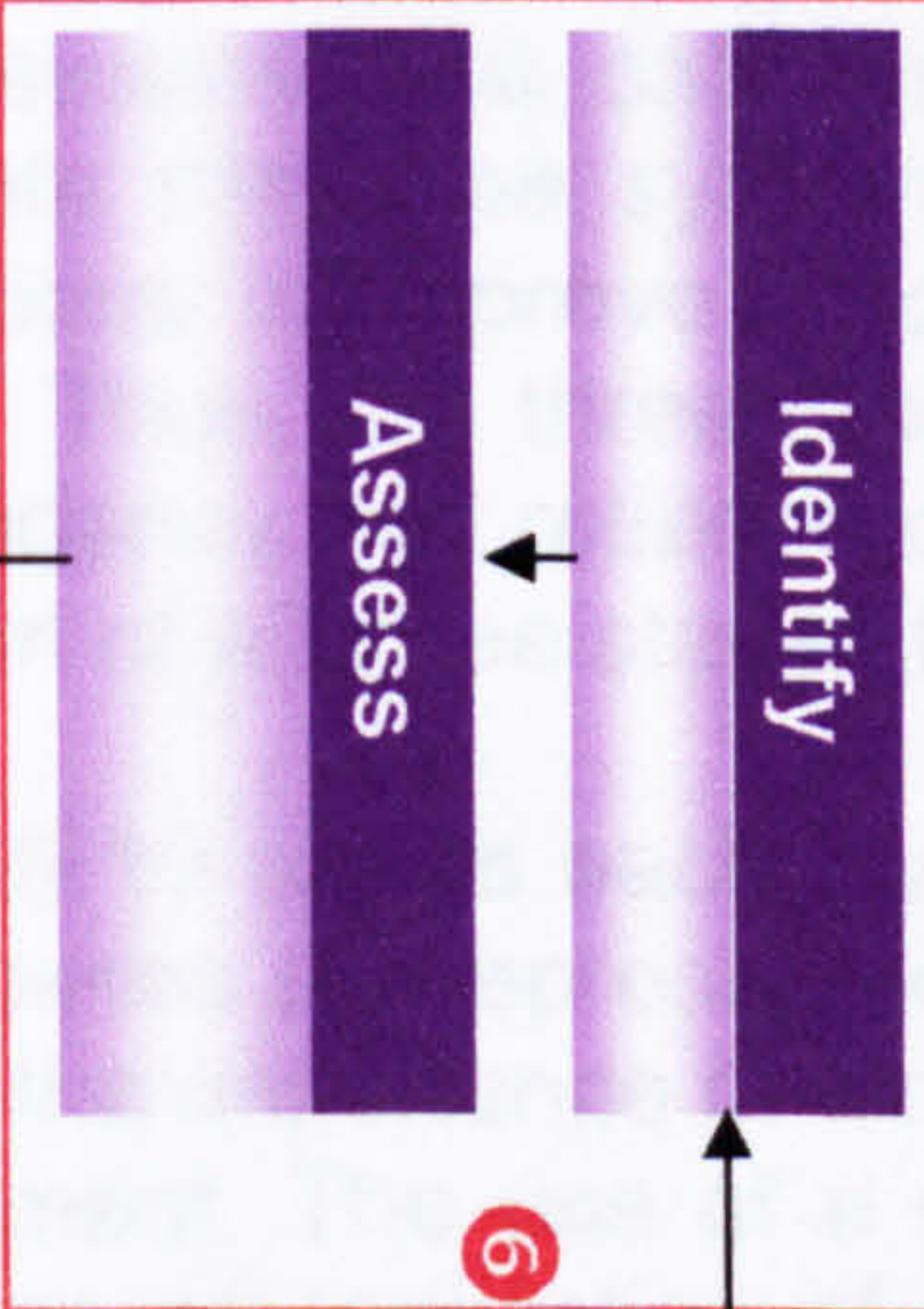
Generic Emergency Management Assessment (GEMA)

4. ... assessed at each stage of the Trident Sequence



5. ...to also show how capable the organisation should be...

1 2 3 4



Focus 1 - preparation

1. Capability is indicated by key processes	
KP1	Human resources management
KP2	Training & development
KP3	Research & development
KP4	Response management
KP5	Organisational learning
KP6	Risk identification & assessment
KP7	Response assurance
KP8	Definition of requirements

2. How well they perform each process...	
Leadership & commitment	
Ability, resources, tools, facilities	
Communications, coordination and integration	
Evidence of verification & management of change	

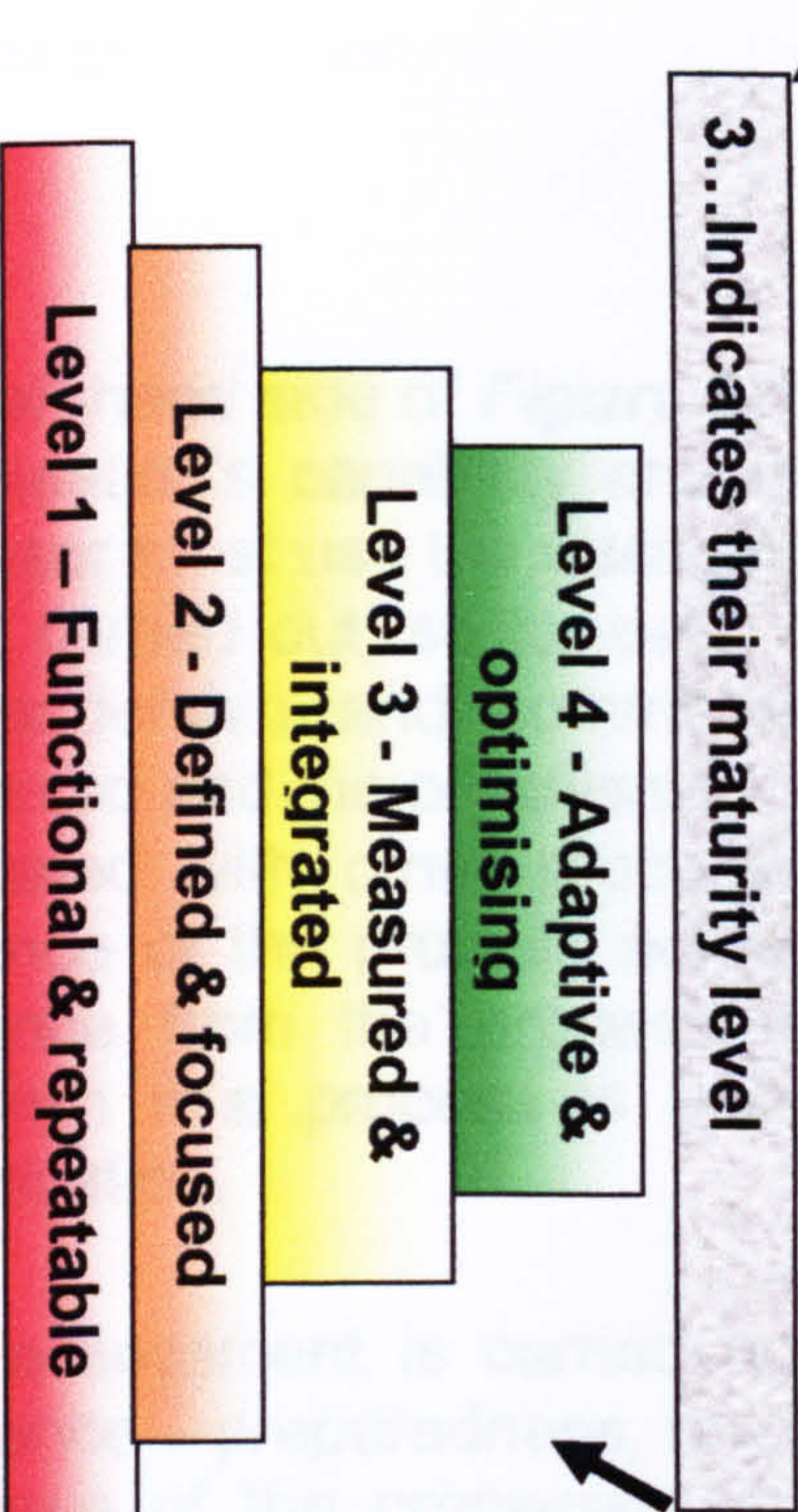


Figure 6-18 GEMA framework description

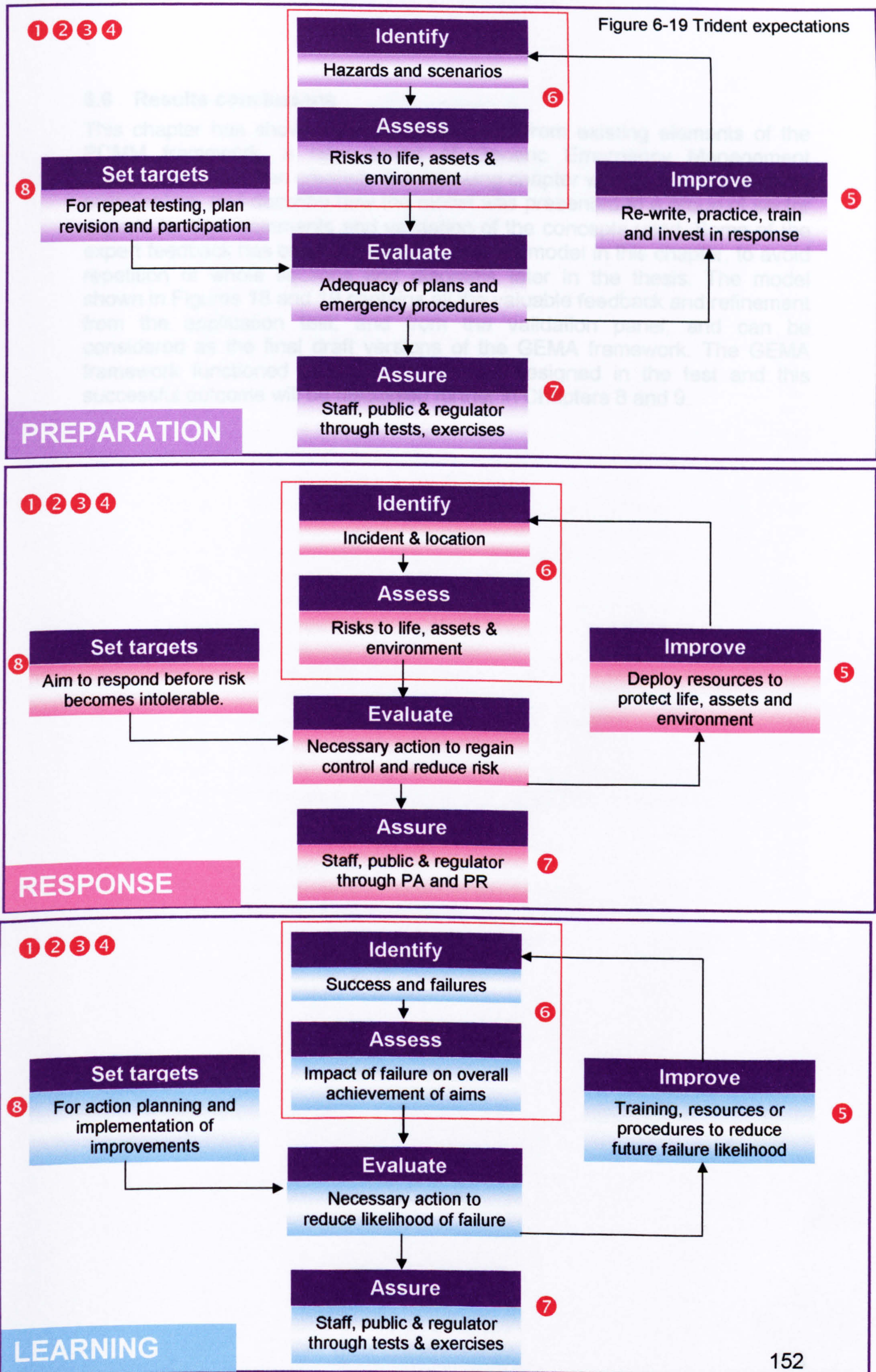
The left-hand side of **Figure 6-18** shows the eight key processes, on which an organisation's capability and maturity are assessed. For each process, the assessor must use the qualifying factors to determine how well that process is being carried out, so for each of the 8 processes the assessor will consider the leadership and commitment demonstrated, how well the process is resourced and the organisation's ability to carry it out, how well that process is integrated with other processes and other agencies efforts, and whether evidence of the process achievements is available. They will also use the guidance from the process descriptions (**Figure 6-6** to **Figure 6-13**) to establish if a process is being considered and carried out by the client organisation.

This assessment is carried out at each of the three stages of the Trident sequence – preparedness, response and learning. At the preparedness stage, evidence of the processes is sought in the organisation's documents and emergency plans, and the assessor seeks physical evidence around the site and facilities. At the response stage the assessor observes an emergency exercise on the site, and uses the evidence to assess whether the processes are carried out when the organisation is placed under the duress of an incident. Finally, the assessor observes the feedback sequence from an exercise and interviews any key personnel, to establish how each of the processes is developed and carried forward by the new knowledge and experience.

The diagram on the right-hand side of Figure 6-18 summarises how the processes fit together, representing the full emergency management system. On the following page there are three diagrams, which show how the focus of the processes changes over the three stages of the Trident sequence. Preparedness, response and learning represent the past, present and future aspects of the EM system. The data showed that while most organisations studied had adequate response systems, the relation to their existing risk portfolio and aspirations to improve efficiency and safety in the future, was found to be lacking. Thus, the three stage Trident sequence was formed to show the interdependency and reliance of each stage on the others, and the reliance of the system of all three stages functioning correctly.

The diagram Figure 6.19 shows each level of the Trident sequence, and how the risk control processes are represented at that level. This is a very valuable diagram as it shows the importance of a risk-control approach at every level of emergency management. The use of a risk control framework in this way is considered to be a novel application of risk theory. This concept is a useful tool as it shows the value of using the same process at each stage of the Trident sequence, bringing standardisation and also increases the significance of the learning stage of the sequence.

Figure 6-19 Trident expectations



6.6 Results conclusions

This chapter has shown how, from data and from existing elements of the PCMM framework, a new model of Generic Emergency Management Assessment has been created. The following chapter will test this model in an organisation, and describe how the model was presented to a group of sector experts for their comments and validation of the concepts used. Some of the expert feedback has been incorporated into the model in this chapter, to avoid repetition of whole sections and diagrams later in the thesis. The model shown in Figures 18 and 19 contains all the valuable feedback and refinement from the application test, and from the validation panel, and can be considered as the final draft versions of the GEMA framework. The GEMA framework functioned as expected and as designed in the test and this successful outcome will be discussed further in Chapters 8 and 9.

Chapter 7

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7 Application of the model

Chapter 6 presented the Generic Emergency Management Assessment framework and described how it could be used to assess capability and maturity in emergency management systems. To appreciate the functioning of the model in a live organisational environment and highlight any problems or errors it is necessary to test the whole assessment framework in a full-scale evaluation. This chapter will show how the GEMA framework was used to test the emergency management capability of a Local Authority, as mentioned in the Methodology, 4.9. The chapter will then go on to describe how the outline of the assessment framework presented to a group of industrial and academic experts for their feedback and advice.

7.1 Testing the assessment framework in Local Authority 'A'

As none of the original organisations that participated in this research was available to carry out a full application of the framework, it was tested in a separate organisation. There were however two benefits to this strategy. Firstly, the test would show how practical it is to apply the model in an organisational setting, and give some idea of the time taken. Secondly, because the example organisation is a Local Authority rather than a private company, the test will inform the study on the efficacy of using the model to assess a wider range of emergency management systems, and examine the validity of the framework's generic nature.

This section will describe how evidence was gathered for each of the key processes, to indicate LAA's capability and maturity at each of the Trident assessment stages. After dealing with all three stages of the eight processes, the overall maturity of the organisation will be argued from the evidence and data gathered. Following this, a short summary of the assessor's experience of using the model will be presented, along with any comments from the organisation being assessed. Full discussion of the test will be presented in Chapter 8, Discussion.

7.1.1 Background to the assessment of Local Authority 'A'

The assessment of Local Authority 'A' (LAA) was opportune for several reasons. LAA had recently introduced a new County Emergency Plan (CEP) which detailed the response of the authority to all applicable hazards. The Authority's staff had been briefed on the use and structure of the plan; however neither the staff nor the plan had been tested in a full exercise. The second benefit of the timing of this assessment was that a major multi-agency exercise was about to be held, and permission was granted for the researcher to attend and observe.

The plan was available to the researcher for review, and the details of that will be presented later in the section. The exercise was held over two days, and the researcher attended both occasions to observe and take notes. Pre-exercise briefing sessions, and a wash-up session following the exercise were also attended, in order to supplement the data for this study.

Due to the request for confidentiality by the organisations concerned, a transcript of the exercise can not be presented, as it would require an impractical level of sanitisation. In order to appreciate the detail of the assessment, it is only necessary to know that LAA jurisdiction covers both urban and rural areas, large and small conurbations and a number of water-courses and major roads. The incident scenario is a road collision involving a vehicle carrying hazardous chemicals, and the resulting leakage from the vehicle requires the evacuation and emergency accommodation of some of the population. Some decontamination was also required. LAA responded alongside the emergency services, and with the organisations responsible for the vehicles and various volunteer groups.

7.1.2 Assessing the processes and the Trident sequence

The capability of LAA in the preparedness stage was assessed by reviewing the County Emergency Plan (CEP), the response stage was assessed by observing the major exercise and the learning assessment was informed by post-exercise feedback and a follow-up interview.

This subsection will explain how evidence from these sources indicates that processes from the EM-CMM framework were taking place, and to what level those processes are being carried out. A brief description of each of the methods of assessment will be followed by a process-by-process account of how plan meets the EM-CMM requirements, and to what standard. When all eight processes have been discussed, a summary will be presented and an indication of the maturity level of the organisation, and for each stage of the Trident sequence will be shown.

7.1.2.1 Brief description of the CEP

The LAA plan was finished in late 2002, and so it addresses the COMAH regulations and other contemporary concerns. It was based on a novel plan model from another Local Authority, and so is markedly different in style to the majority of the 'traditional' plans studied in the Data Analysis chapter. The plan is called the Emergency Procedures Manual and is made up of role-focussed sections. It contains flow-diagrams, checklists and templates of documents, to support the initiation of the plan, and then assist each role-holder in their tasks. It is physically indexed using coloured sections and dividers, and is intended to be used during an incident as a reference guide.

Comparing this plan to the majority of other plans studied for this thesis, one would initially comment that it is by far the most superior in terms of ease-of-use and potential value during an incident. It is also the most comprehensive emergency management resource seen by this study. The plan demonstrates that the organisation has considered many additional issues which are outside the scope of the regulations, but are considered to be desirable practice in the field. From an initial examination of the plan, it appears to facilitate the type of assessment required by GEMA.

The following section will describe the emergency exercise carried out by LAA, and observed for this study.

7.1.2.2 Brief description of the emergency exercise

The exercise was a large-scale live exercise, testing county-level response and incorporating some trans-boundary impacts and interaction. The exercise duration was two days with one day feedback and learning, and was observed from the LA control room. The exercise included use of several communications methods, and there were approximately 30 LA staff involved on the first day, slightly less on the second day as the incident was scaled down, and all the staff from most agencies present on the third day for feedback and follow-up actions. The facilities provided for the exercise were of an adequate and sustainable standard, and there had been a considerable amount of planning for the event.

As mentioned previously, several different agencies were involved in the exercise, and this was reflected in the complexity of the scenario. The cost of the exercise was large, but was shared between the major organisations participating. The level of realism and the scale of the information barrage in the exercise were high, and each organisation had its own pre-defined objectives, alongside the combined response objectives. Although effective testing of roles, communications and of the plan structure can be carried out on a smaller scale, this scale of exercise can be an excellent, although expensive means of testing all elements of the combined response to a major incident.

7.1.2.3 Brief description of the 'learning' assessment

In this case, the learning mechanisms were put in place as the scenario was being constructed. The objectives and means of recording performance for each of the participating agencies were discussed and incorporated into the exercise. Records and logs were kept during the exercise, and a considerable amount of time on the third day was devoted to debriefing and feedback.

The debriefing took several forms, ranging from small group discussions to a full plenary of all the participating agencies.

As the researcher did not participate in the debriefing, and only observed the proceedings, there remained some questions unanswered from the plan and exercise. It was for these reasons that a further separate meeting was held between the researcher, the exercise coordinator and the Chief Emergency Planner for LAA. This was most useful to consolidate the assessment, and draw the procedure to a close. It also enabled the organisation to seek clarification on any part of the assessment, and offer any additional evidence which they feel may provide a more detailed view.

7.1.2.4 Process assessments- Trident assessment

The following section is made up of diagrams showing the detailed process assessment.

Figure 7-1 Human Resources Management Process – Trident sequence assessment for EM-CMM

Human Resources Management Process		
Preparedness	Response	Learning
<p><u>LEVEL 2</u></p> <p>The teams were structured to respond to the risks, and the plan had mechanisms to adapt the staffing to meet new requirements. Although monitoring and measurement of roles was carried out at level 3 standard, the teams' coordination and integration did not meet the requirements of level 3. A sound leadership structure was demonstrated through the plan and the investment of time and effort in the plan and number of staff involved, indicated that the process was adequately resourced. The plan gave a sound level of detail regarding the communications methods and channels, and means of coordination, but integrated HR coordination was not strongly demonstrated in the plan. An aspect of this stage which was level 3, was the use of staff who had skills and training from their regular posts, in similar positions in the EMT. This builds towards competency-crossover, between the individuals' regular job and emergency role. This is a desirable asset as it makes training and competency building much more efficient and effective.</p>	<p><u>LEVEL 2</u></p> <p>The roles and responsibilities were coordinated during the exercise; however there were a few staff that were not comfortable in their roles. There were sufficient numbers of staff to safely and effectively respond to the circumstances, and a sustainable shift-system was demonstrated. There was insufficient staff coordination between strategic and tactical levels, and between agencies to meet level 3 requirements. The internal leadership in the ECC was good, but strategic leadership was lacking. The teams did not fully appreciate the resources that had been allocated in the plan, but communication was well structured and frequent in most areas, with a notable exception of feedback to the communications operators, which was seriously lacking. Management of change, in terms of changing the shift, was structured, accountable and efficient. Org was continually reassessing the HR requirement at the incident scene, and responding accordingly. LAA showed a high regard for monitoring staff stress and comfort.</p>	<p><u>LEVEL 3</u></p> <p>The opportunity to learn from the exercise was presented to, and used by all the staff involved. This organisation is a clear level 3, as the staff involved in the response is responsible for similar tasks and areas that they would handle in their regular jobs. This means that lessons learned in their regular post benefits their EM performance, and lessons learned in an emergency benefits their regular jobs. This has been called 'competency-crossover'. The learning stage was facilitated by the same staff who led the response, which gives valuable continuity to the sequence. There are several template documents to facilitate, record and measure feedback and learning, however deficiencies in the integrated learning between the different agencies is the only aspect of this process which is barely level 3 standard.</p>

Figure 7-2Response Assurance Process – Trident sequence assessment for EM-CMM

Response Assurance Process		
Preparedness	Response	Learning
<p><u>LEVEL 3</u></p> <p>The plan assigns responsibility for keeping the response staff up to date. The strong, integrated media plan is evidence if a high level of public assurance. The plan demonstrates accountability through a documented system to assure the public who call the helpline telephones, assurance to staff at the scene and other agencies through an on-scene liaison. There is a technical plan to implement web-site statements as well as traditional media; the plan document itself provides assurance that the organisation is capable, prepared and forward-looking. The PR team monitor the media to confirm accuracy and effect of their output, and adapt accordingly, indicating a high level 3 along with the interagency coordinated media approach. Commitment to the Press and PR aspects of the plan is very high, and professionally planned. Leadership of the combined PR strategy is a little unclear from the plan. This authority has also ensured that copies of its plan were distributed to specialist libraries to ensure that others could share their methods.</p>	<p><u>LEVEL 2</u></p> <p>Frequency and timing of telephone enquiries are plotted on a map, to indicate where further assurance may be necessary. Media management and press releases are handled effectively. Coordination of PR effort is weak, and some problems of leadership and control were demonstrated. Measurement of assurance is used, so level 3 is within reach. Leadership of assurance within the ECC was good; however the combined media response was uncoordinated. High commitment by all. There were resources in place to deliver the media response, but little to facilitate the monitoring of media impact during the incident, which would be a level 3 capability requirement. The inadequate demonstration of communication, coordination & integration between the EMT and other agencies prevented this process stage from achieving level 3. Information to evacuees and those in the care of LAA was demonstrated as well planned and coordinated throughout the exercise.</p>	<p><u>LEVEL 3</u></p> <p>LAA suffered a recent natural-based emergency, and as a result is launching a public information roadshow. The integration of learning in this process was noticeably good. Inter-agency learning was well managed, as teams were split into mixed groups to review and feed back on certain aspects of the response. This ensured that each agency was assured of the response capability of the others through the learning stage. Alongside 'exercise' response assurance, the real media were given details of the exercise and the reasons for it, which were reported widely and further strengthened the organisation's actual response assurance. In the learning stage, leadership and commitment were shown by the majority of responding agencies, and the LAA were equipped with the tools, and the information recorded in the scenario, to initiate the learning procedures. Verification across the agencies that they had learned from the incident was achieved, and so level 3 is appropriate for this organisation.</p>

Figure 7-3Organisational learning Process – Trident sequence assessment for EM-CMM

Organisational learning Process		
Preparedness	Response	Learning
<p><u>LEVEL 3</u></p> <p>The plan contains templates of checklists with time targets and fields for recording quantitative outcomes. Plan also provides handover sheets, to enable personnel leaving a shift to record all important information for transfer, and also for a record of the incident at the hand-over stage.</p> <p>A prescriptive guide to standing-down the response is also provided. This requires that a range of debriefing and recording tasks are carried out and a person is accountable for their completion. The quality of leadership demonstrated in the preparedness stage is sufficient, and one would conclude from the measures outlined in the plan, that the organisation is committed to OL.. This commitment also appears to be shared by the other agencies involved in the response. The plan provides template documents as the means to record information for later analysis and learning, and so the ability to carry out the process is demonstrated, and it showed how parts of the learning were coordinated and integrate with other agencies, however there was no evidence in the plan of verification of the learning outcomes, or how the management of any changes identified would be carried out.</p>	<p><u>LEVEL 3</u></p> <p>Data gathered is analysed during the response to give the EMT information on emerging trends, and possible new foci for their attention. This allows the response to continuously adapt and improve to meet the emerging needs of the incident. Although this is a level 5 characteristic, the organisation is being placed at level 3 because the teams understanding and use of the recording and analysis procedure was not demonstrated to level 5 standards on this occasion. Although template documents were filled in and hand-over procedures completed, some staff did it because it was expected of them, not because they had a full understanding and appreciation of the value of the information. In the response, one got the impression that the leadership and commitment to this process was not as strong as it could be, despite the adequate provision of a good system and resources. There was perhaps a lacking element of communication and coordination, as some of the staff appeared unfamiliar with the plan itself, and the information recording requirements. There was continual verification that the data being completed for instant analysis was being filed correctly, however other general recorded data was not verified during the response.</p>	<p><u>LEVEL 3</u></p> <p>During the learning stage, the organisation was assessed as only just a level 3 because there was little sharing of knowledge or learning demonstrated between the agencies involved in the response. Although there were some confidentiality issues involved, in some cases information was not shared, even when more than one organisation had commissioned observers to assess the exercise. The LAA's commitment and leadership to the learning phase was however exemplary, and may staff had made their own independent notes to aid their learning from the incident. The fact that LAA were producing and circulating an incident debriefing report to other agencies is of a level 3, standard and only requires sharing of quantitative targets to demonstrate sound level 3 performance. The ability to share and benefit from such information was present, but not fully coordinated. As LAA was not the 'lead agency' in the response, it would be unfair to hold them responsible for lack of coordinated multi-agency learning; indeed they demonstrated the ability and willingness to contribute well to such learning. Verification of experience and knowledge was shared on an individual and team level in small, interagency feedback groups.</p>

Figure 7-4Research & Innovation Process – Trident sequence assessment for EM-CMM

Research & Innovation Process		
Preparedness	Response	Learning
<p><u>LEVEL 3</u></p> <p>The emergency plan was a novel style, and was designed as a result of sharing research with another local authority. The style of the plan is distinctly different from all the other plans used by this study, and appears more appropriate to the contemporary field and conducive to more efficient and effective emergency and risk management. Whilst LAA EM section does not have a research budget as such, there is allowance to spend on research. There is also evidence of employing novel methods as part of their activities, and developing novel methods from other sources for their own application, and so level 3 is appropriate. The plan also encourages innovation through the response, as the role of on-scene liaison officer is tasked with providing appropriate resources and support to the operational response, which could be from pre-defined sources or novel acquisition. There is no evidence of defined leadership; however the plan demonstrates a organisational commitment to novel approaches and development. Evidence is also shown of the ability and resources to use novel methods. The staff attend national and regional conferences, and are part of regional coordination groups, so willingness to develop innovative initiatives and seek new knowledge is shown.</p>	<p><u>LEVEL 2</u></p> <p>The response demonstrated innovation in several instances. Firstly, when the logger failed to arrive at the ECC, the team adapted their roles to ensure that the logger's duties were completed. This continued for a considerable time into the response. There were also other examples of innovation involving new techniques and equipment, where an idea was suggested and followed through to successful completion.</p> <p>Several areas of weakness were identified in the response, and it was suggested that research might be a useful way of addressing these. No firm commitment was made however. Leadership and commitment to innovation were demonstrated, and the organisation has shown the ability to use innovation within its team structure. The need for innovative practice in replacing the logger, and in certain technical problems was communicated well within the team; however there was no evidence of coordinated innovation with other agencies, nor verification of innovative practice with other organisations or sources.</p> <p>LAA has been involved in training others to respond to emergencies within their own area of local government.</p>	<p><u>LEVEL 2</u></p> <p>The learning stage of this assessment proved that the process of innovation was taking place, and it was being carried out in an integrated fashion. The feedback and learning sessions were innovative in their structure, which put together small multi-agency groups to discuss the incident response, and report back to the wider group in a final plenary session.</p> <p>Following this, the exercise coordinator laid out the plans for the future and how deficiencies identified by the exercise were to be addressed and remedied. A smaller group was then established to take these issues forward and plan the changes and actions resulting. In the learning stage, this process had strong leadership in trying to develop innovative solutions, however the commitment and ability to carry out the actions has yet to be proven. An observation at some point in the future to determine what changes have been made, and how the problems have been addressed will verify that the organisation fully appreciates this process. There is very little that prevents this stage being awarded level 4, the key factor being that there was no demonstration of a measured approach to learning from innovation or planning future research.</p>

Figure 7-5 Definition of requirements Process – Trident sequence assessment for EM-CMM

Definition of Requirements Process		
Preparedness	Response	Learning
<p><u>LEVEL 3</u></p> <p>Regulatory compliance was outlined in the plan, and the organisation also sought to measure the extent to which their preparedness met the expectations of the wider public, through direct public consultation and liaison through elected members. The plan also contained details of the structure of the EMT, and how this was managed through shifts, to ensure that the levels of stress in any individual were managed appropriately, thus addressing their human and wellbeing requirements.</p> <p>The plan also allocated a member of the team to act as on-scene liaison, which saw any changes in requirements or arising needs in the incident immediately communicated to the EMT. The plan showed evidence that the organisation had considered a wide remit of requirements acting on it. It also shows that they are committed to continual reassessment of those requirements, and illustrates that they have the ability to keep abreast of the changing situation.</p> <p>The plan indicates that the means to communicate and coordinate changes of requirements are in place, although no formal verification of this is indicated.</p>	<p><u>LEVEL 3</u></p> <p>The exercise showed evidence that the organisation was capable of continually updating its understanding of the requirements placed on it. It addressed the needs of vulnerable groups in the community when considering its evacuation protocol and was continually reassessing the information requirements of the public, by analysis of the enquiries into the call-centre and monitoring of the media releases and interpretation.</p> <p>The regular 'time-out' updates, lead by the EM and DEM, provided opportunities for the different response teams to highlight their response to changing requirements. The frequency and detail of the time-outs illustrated the organisation's commitment to this, and the successful outcome of the tasks shows that they had the ability and resources to respond to their changing remit.</p> <p>The presence of liaison officers, one at the incident scene reporting to the ECC and a second in the ECC liaising with the 'Gold control' enabled the teams to communicate and coordinate effectively. Although there was only internal verification between the different levels of response, the organisation has show that it can effectively manage change during the response stage of this process.</p>	<p><u>LEVEL 3</u></p> <p>A joint, integrated approach to feedback gave each group the opportunity to feedback its satisfaction with the incident, and any requirements for improvement. Records of the response were analysed, and feedback surveys with quantitative components were taken during the learning stage.</p> <p>The organisation recognised the need to reassess its view of the response requirements following the exercise, and mechanisms for the staff and other agencies to contribute, worked well. The organisation took a firm lead in the learning stage; a significant amount of time and resources was spent on ensuring that the organisation got the maximum value from the exercise. There was no doubt in the assessment that the organisation was committed to the learning phase, and coordinated its role in the learning very well, although it was not the lead agency in the response.</p> <p>External verification in the form of a consultant was present and contributed to the learning phase, after observing the exercise and reading the plan. Much of the consultant's report reinforced what the organisation raised in the learning phase through its own analysis.</p>

Figure 7-6 Training and Development Process – Trident sequence assessment for EM-CMM

Training and Development Process		
Preparedness	Response	Learning
<p><u>LEVEL 2</u></p> <p>The plan give little detail of the training and development of the individual post-holders, however it does provide comprehensive role-specific sections to aid each team member with their duties. The plan provides evidence why certain roles should be called-up, and how the expertise offered by that post-holder is used. Because of the close link between the standard role and the emergency management role of many individuals, many of their skills and experience in their regular job are transferable competencies applicable to the emergency management situation.</p> <p>The plan made no reference to continual training of individuals in their emergency management, or records of such training, however, the final interview with the CEPO highlighted that the staff were selected on the basis of their line manager's assessment, and 'their level of common sense'. Training records are kept, and training is still task-based, although they are moving towards competency-based training. The training of the individuals, and the exercising and development is clearly linked to the requirements of the response, and the plan makes provision for performance records to be kept during an incident. There is one major multi-agency exercise per year.</p>	<p><u>LEVEL 2</u></p> <p>The teams kept records of performance during the incident, guided by the plan. Although no formal EM competencies were apparent during the exercise, it was clear that there was significant competency cross-over between the EMT members' regular jobs and their EM roles, so many of their work-developed competencies were used in the emergency situation. Requirement for further training in completion of the 'message record' forms was identified, as there were repeated errors during the incident. It was also apparent that very few of the responders actually used the prepared role-specific sections in the plan during the course of their duties, although they had been trained to use it. The Press relations staff exhibited very strong competency-cross-over, and responded very well throughout, showing level 3 qualities. The organisation showed commitment to continual staff development. Leadership and support for development was present within teams, but not seen at a higher level. The high competency-crossover indicates that the organisation has the ability to develop and train its staff well, but there was little verification of this, or evidence that the organisation could deal with personnel changes.</p>	<p><u>LEVEL 2</u></p> <p>During the learning stage, the staff were asked if they felt that further training was required in any areas. Many members of staff highlighted response problems, and the exercise coordinators noted these concerns to build into future training.</p> <p>The fact that staff carry out a similar role in their regular job as they do in their emergency position leads to competency cross-over, which ensures that LAA has an integrated skills base and greatly improves their emergency management, and makes any training beneficial to both areas of the organisation's work.</p> <p>A final interview with the CEPO identified that refresher training is carried out, and staff evaluate the effectiveness of such training. Mentoring takes place within the teams, however it is not formalised. There have been cases of the EM and DEM undergoing periods of experience with other response agencies, but this is not a regular structured activity. Staff involved in the response are also encouraged to assess their own performance; however this is not part of a wider development recording regime. If these ideas and schemes were formalised and measured, then the organisation would be assessed as maturity level 4 for this stage.</p>

Figure 7-7 Response Management Process – Trident sequence assessment for EM-CMM

Response Management Process		
Preparedness	Response	Learning
<p><u>LEVEL 3</u></p> <p>The organisation is placed at level 4 for this process because it has shown commitment to quantitative resource targets in emergency management. The plan indicates that resources are also shared and coordinated between the different responding agencies. The plan provides the structure for this resource integration.</p> <p>The plan details how resources are available at the main ECC in the form of ‘crash-packs’ for each post-holder in the EMT, and similar resources are also mirrored at a back-up ECC. There are also back-up lighting generators should the electrical supply fail. This illustrates potential to manage, should the environment in which the response is conducted undergo any change.</p> <p>The response to hazardous incidents of this level, requiring decontamination and evacuation, was well prepared with the majority of resources and facilities in place and tested. There were some unforeseen problems relating to transport and cordons, however the majority of the response preparation was exemplary.</p>	<p><u>LEVEL 2</u></p> <p>The physical environment of the ECC was adequate for the purpose assigned, however some equipment and resources for the communications operators was inadequate. The ECC required a little configuration by the EMT before it was fully operational, and this element of the response must be practiced and ongoing measures taken to ensure that the facilities are ready for activation at any time. The response was rather dependent on the use of mobile telephones, as there were only two telephone lines into the ECC, apart from the helpline telephones answered by the communications operators. Volunteer operated radio back-up was available, although it is usually a last resort. The communications operators were particularly unsupported by the facilities, with inadequate physical technology to perform effectively and insufficient and outdated information fed to them by the EMT. Information management techniques were used in the ECC, however the absence of a logger made the display boards chaotic and under-used. The resource management was defined and focussed, but required maintenance, consultation with the users and drill sessions.</p>	<p><u>LEVEL 2</u></p> <p>The resources and facilities available for the learning stage were far more adequate than any other exercise observed for this study; however there was still room for improvement. Each layer of responders was debriefed when they left their shift, including a hand-over period where they were working alongside the new shift. More senior members of the EMT were required to fill in a hand-over report, and discuss this document with their successor before signing off. The out-going EM was also required to be on call for 30 minutes after his shift to deal with any immediate problems.</p> <p>Template documents, time allocations and facilities were set aside for this transfer of knowledge, and it was handled in an exemplary fashion. All staff were given the opportunity to feedback to the exercise coordinator, through verbal discussion and through written feedback forms, and this information was recorded for later analysis. There was no evidence of statistical or quantitative analysis of performance and of the response management, and so level 4 can not be awarded, although there was some feedback and learning integration with other agencies regarding the response management issues.</p>

Figure 7-8 Risk ID and Analysis Process – Trident sequence assessment for EM-CMM

Risk Identification & Analysis Process		
Preparedness	Response	Learning
<p><u>LEVEL 3</u></p> <p>The plan uses an all-hazards approach, which can be used to manage any emergency situation. LAA employs risk and safety officers, so the plan was based on their full assessment of the risks facing the county and the authority. The plan was designed to be used in addition to a Geographical Information System (GIS) giving the EMT and planners access data stored on static and portable computers. The data included maps showing the vulnerable and special population locations (elderly, young, prisoners and mental health residential centres. The GIS also contained details of highways, waterways and railways, lists of volunteer groups and emergency resource locations and demographic and environmental information. The GIS could be used to geographically plot any hazard, and identify likely vulnerable sites, allowing the potential magnitude of the risk to be analysed and prepared for. Leadership and commitment to this process is very high, and the organisation has the ability to carry it out thoroughly. Risk is understood and communicated throughout the plan and the organisation, and evidence of the ability to manage and address changes in risk is apparent.</p>	<p><u>LEVEL 2</u></p> <p>Although aspects of the RI&A process in the response were excellent, there was an overall lack of coordination which prevented the organisation being placed at level 4. Aspects of the on-going risk assessment of the incident were quantitative, and some decisions were based on this numerical analysis. Different emergency response agencies carried out their own hazard and risk assessments, and expected a definitive answer from LAA before proceeding; however the risk decision-making within LAA was not structured well enough to provide firm, decisive answers. The leadership and commitment aspect of the process were strong, with the EM and DEM providing decisive and rapid risk-based decisions, where information was available. There were instances however where data and technical guidance were not available, and decisions on risk were delayed, so the ability to carry out this process was not demonstrated thoroughly. Risk information and decisions were not coordinated well, which is a failing in a major incident of this nature. Between the 'gold' strategic command, LAA ECC and the incident scene there could have been a firmer hierarchy of decision making. In the response, evidence of the ability to manage a change in situation risk, was lacking.</p>	<p><u>LEVEL 2</u></p> <p>In the learning stage of the assessment, the organisation showed a team-level awareness of the risk issues in the response, but there was no overview of the response risk issues from a higher level. The learning stage was focussed on recording and finding ways to address the errors in the response, and preserving and incorporating the aspects which had been successful.</p> <p>Level 2 was awarded because although there were examples of supreme effort to learn lessons and improve risk management, there was insufficient interagency coordination of this aspect. Leadership and commitment within the teams and agencies was proven, but not at a higher strategic level. The presence of permanent risk management staff within LAA indicates that the ability and commitment to improve are there, however level 4 integration and communication of risk learning was not evident. One could confidently conclude that LAA has shown the capability to manage change in risk and learn from experience; however greater learning is accessible to them through coordination with fellow responders.</p>

7.1.3 Process assessment summaries

The following section will summarise the assessment of each process and conclude by assessing the maturity level for that process. Assignment of a process maturity level is based on the maturity of each stage of the process, and the overall impression of how that process is conducted within the organisation. It is not necessary for each process Trident stage to be at maturity level X in order for the process to be assessed at level X, although the majority of the process should be performed at that level in order for it to be a consistent assessment. Each process will be summarised in a paragraph, and the section will finish with a concluding argument on the organisation's overall maturity level indicated by the assessment.

7.1.3.1 Process maturity for Human Resources Management

This process has been evaluated as an overall level 3, because of the predominance of the positive achievements of competency-crossover, measurement and assessment of role adequacy and ongoing HR adequacy monitoring in the response outweigh the minor nature of the downfalls in this process. There were a number of staff, who were uncomfortable in their roles, but on further examination they were staff who had missed out on pre-exposure to the new plan, and they were unprepared for the whole exercise experience. The lack of feedback from the EMT to the communications operators was a serious oversight, but was the result of a member of staff being unfamiliar with their role, and so was not an inherent error in the preparedness. A key requirement of HRM at higher levels is that there is a level of integration between the roles of the staff in their regular jobs and their emergency positions, to ensure a sustainable human response. As LAA demonstrates an understanding of closely linking organisational and emergency HR, level 3 is appropriate.

7.1.3.2 Process maturity for Response Assurance

This process is assessed at level 3 overall, as it demonstrates a strong, sustainable culture of public and staff assurance. There are structures in place to monitor and adjust assurance continually, to address any change in the requirements of the situation. There is a high level of internal integration within the LAA, however they could integrate their assurance efforts, including PR strategies, with other responders to a higher degree. Lack of this integration in the response resulted in delays and withholding of information, rather than quick, rash and uncoordinated releases. However, there is room for greater coordination. Outside the scenario, LAA organised media coverage of the exercise as part of their 'real-time' response assurance strategy.

7.1.3.3 Process maturity for Organisational Learning

This process has been assessed as an overall level 3, as internal commitment to learning is very high. Integrated learning was demonstrated to level 2 standard in the response studied, however a mitigating factor was that LAA was not the lead-organisation in the response, and so did not have overall control over the level of integration and knowledge sharing that occurred in the learning phase. They demonstrated however that had the framework been

in place, they had the ability to integrate their learning with others for mutual benefit. The plan was designed to facilitate measurement and recording, and the response demonstrated the ability to record and measure performance during an emergency. Minor problems in the response can be attributed to the fact that this was the first exercise using the new plan, and quite an atypical exercise for LAA, so it is with confidence that their capability is assessed at level 3.

7.1.3.4 Process maturity for Research and Innovation

This process has been assessed at maturity level 2. The main reason for this is that there is no evidence of measurement in the research and innovation that is carried out. Other aspects of the process are conducted at level 3 standard, including the control of innovation during response, the use of innovation in planning and preparedness strategies and the coordination with other agencies in some research and novel approaches. The lack of a budgeted and measured approach to research could be due to the internal structure and politics of the Emergency Planning department of LAA, as a local government organ; however such speculation would be outside the remit of the assessment. Overall, the organisation has shown commitment to continual advancement and innovation, and as such, would easily move to level 2 when measurement criteria were introduced.

7.1.3.5 Process maturity of Definition of Requirements

This process was assessed at level 3, because the process was found to be conducted in a professional and thorough manner demonstrating an insightful understanding of contemporary and changing nature of the requirements for emergency management response. The preparedness was integrated and measured to an extent, but strengthening of this could easily be achieved. It demonstrated that the organisation actively sought to determine the requirements of different stakeholders by several different mechanisms. The plan also indicated a wide understanding of the physical and psychosocial requirements of the response staff, and mechanisms to protect their well-being. The response demonstrated continuous appraisal of the demands being placed on the EMT by the media and other organisations, and was well structured and recorded details for future analysis. The feedback and learning were integrated with those of other agencies, and the structure provided by the plan facilitated the learning stage very well. Verification was also conducted for LAA by an external consultant.

7.1.3.6 Process maturity of Training and Development

This process was assessed at maturity level 2, but shows clear potential for movement up to level 3. The organisation is currently using a task-based approach to training and development, where each individual is trained to carry out the tasks they would face in their emergency role. They are moving towards a competency-based approach, where the individual's competency is developed in several areas, to enable them to complete a range of tasks. There are a number of level 2 attributes which lay the foundations for level 3, and with formalisation and measurement, the process would be performing at maturity level 3. Basic level mentoring, self-assessment and selection are present and essential requirements to be advanced for level 3. Further

development of individual training records and structured development to formalise the competency-crossover would raise the process to level 3 standards.

7.1.3.7 Process maturity of Response Management

This process was assessed at level 2, because although deficiencies in internal resource management arose during the response, no effort was made to address them. The plan indicated a high level of resource integration and preparedness, and some of the problems from the response can be attributed to the fact that the plan had not been fully tested until that point. There was a level of inefficiency in the response, where perfectly good resources were available to the EMT, but were unused. Examples include display-boards which printed their contents, computer terminals and the GIS system, which suffered configuration problems for most of the first day of the exercise. The resources available and committed to the learning stage were very good, as the organisation had built the plan and response to facilitate learning, but measurement techniques and systems were not included. Useful measurements would have been of resource adequacy and use, satisfaction with resources and some cost and value analysis. This would facilitate continual improvement, and higher level sustainable performance.

7.1.3.8 Process maturity of Risk Identification and Analysis

This process was assessed at maturity level 2. The main reason was the lack of coordination in the risk-based decision making during the emergency response. The plan and preparedness are of level 3 standard, and the staff are in place to provide a professional input to any risk related issues. The GIS is an excellent tool, and provides real-time risk-based decision support, however the Emergency Planning Department used a different version of the software to the other departments of LAA, and so there was limited interfacing, and therefore reduced utility and conflicts during the response. Although some risk-based decisions were taken by the response teams, the EMT did not coordinate the decision-making well with other agencies in the response. The learning stage is also assessed at maturity level 2 because of the absence of communicated risk-related learning and experience. Once again, LAA was slightly limited as it was not the lead agency in this exercise, however, a more structured and measured approach to learning would be required to meet level 3 standards.

7.1.4 Overall maturity level for emergency management in LAA

The assessment has shown that half the processes are performed at level 2, and half at level 3. At the Trident sequence level, the assessment is the same, with half of the stages performed at level 2 and half at level 3. Although it is tempting to assign weightings to the processes to make such a decision as this easier, that would be introducing more bias and subjectivity into the assessment, which is precisely what this study set out to avoid. The original PCMM works clearly by the rule that unless all the processes required for level 3 are performed to an adequate standard, then the organisation can not be assessed at that level, because the processes are of equal importance and must all be in place to ensure a foundation for level 4 practices. If this assessment were to assess LAA at level 3, as some of the processes

indicate, this would communicate to the organisation that they were ready to work towards level 4. The requirements of integration, coordination and interdependency needed as a basis for beginning maturity level 4 processes are clearly missing from some processes highlighted in this assessment, and so the organisation is placed at level 2 until those problems are addressed and evidence is presented to indicate level 3 performance. The ethos of CMM is continual, staged improvement and for that important message to be translated into the emergency management field, it should be recognised that until every process is performing to level 3 standards, the organisation would not be able to consider introducing more advanced development strategies, as commensurate with level 4.

7.1.5 Issues raised by the framework test

This test of the framework was a very valuable experience, because it highlighted some of the practical problems of using the assessment in an organisational setting, and also any issues arising from using the framework designed for use in private sector Major Hazard Industry in a public sector local government department. These issues are discussed further in 7-1-5-1 to 7-1-5-6.

7.1.5.1 Language and terminology

During the first two stages of the assessment, the role of the organisation was passive, as they were simply being observed and there was no interaction with the researcher. In the third stage, a semi-structured interview was used to answer queries from the earlier stages, and attempt to clarify some performance issues. When some of the processes were discussed with the CEPO and his staff, it was not immediately recognised that such an activity was undertaken by the authority. After further discussion and description, it became clear that the organisation actually did carry out the process; however it was referred to as something different, and undertaken by other means. The reason for the initial failure to recognise an activity was the language being used to describe it, and a difference in terminology.

This was due to two factors. Firstly the use of management terminology, and especially USA management expressions incorporated in CMM, did not make it clear what was being described. Secondly was the difference in terminology between the industrial hazard roots of the new framework, and the local government structure and systems used by LAA.

One would conclude that if the framework was to be used for Local Authority and other public sector emergency management assessments, the assessor must be aware that the terminology will be different, and probe deeper during the clarification interview. Thorough explanation of the processes is usually enough to enable the interviewee to relate it to relevant practices carried out within their organisation, and it is important to establish such an understanding with the interviewee, in order to conduct a fair assessment.

7.1.5.2 Hierarchy of agencies in the response

Certain attributes and decisions assessed in the response stage were related to issues controlled by the lead agency. LAA was not the lead agency on the

occasion observed, and it was not the agency responsible for planning or funding the exercise. This resulted in LAA being assessed on decisions and actions which were beyond their control. Where this has occurred, it has been mentioned in the assessment, and credit may have been given for the willingness or aptitude to carry out that process, if given the responsibility.

This problem would not arise when the framework is used for Major Accident Hazard Industry assessment, because they remain in control of matters concerning their plant and personnel during an emergency, although they interact closely with off-site emergency services when appropriate.

If the framework is to be used for assessment of Local Authority emergency management systems in the future, it will require some adjustment to take account for occasions when certain aspects of the plan or response are under the control of a third party. On this occasion, the distinction between the remits of LAA and the lead agency was clear, and the assessment was not disrupted in a serious fashion.

7.1.5.3 Test of preparedness phase

For the LAA assessment, the researcher only had access to the County Emergency Procedures Manual. In a full assessment, the assessor should use any document relating to emergency management, human resources and organisational policy to inform his or her assessment of the preparedness stage.

In a private sector Major Accident Hazard organisation, research experience has shown that this documentation is relatively easy to access and is usually contained within a wider 'Health, Safety and Environment policy' with aspects also appearing in the 'Corporate Social Responsibility' and 'Regulatory compliance and legal duty' documentation. The LAA documentation was in the process of being reviewed, and responsibility for emergency planning being transferred to a different section, so the recently revised Procedures Manual was the only available document.

7.1.5.4 Test of learning phase

The assessment of the learning phase was the most difficult to complete in this trial. This is because a proportion of the learning debriefing (for operational and administrative staff) were carried out more than a week after the exercise, during normal working hours, and also because the one-day debriefing event was quite fragmented. The event split up the personnel into multi-agency discussion groups, who discussed the response and made informal notes on key aspects of their experience and how they would take the learning further. It was not possible for the researcher to observe each group for the whole discussion, so a general overview of all the groups was obtained.

The groups were brought together for a final plenary session to bring any salient points to the attention of the chair, and ensure that they were recorded formally in the minutes. This provided the opportunity to raise most areas of concern, however some personnel may have felt unable to contribute in a very

large, chaired formal setting alongside very senior colleagues and third parties, so some issues may have gone unheard. Possible improvements to the learning phase assessment will be developed further in the Discussion, Chapter 8.

7.1.5.5 Assessing Management of Change in processes

The final process qualifier statement assesses the 'evidence of verification and the management of change' which required further clarification in the assessment. Verification is relatively easy to determine, however the ability to manage change in a process should be more carefully defined to avoid confusion. The statement should seek evidence of the organisation's ability to carry out that process if the circumstances change. For example, in assessing Response Management, a change in circumstances might render the ECC unusable or without electricity, so the ability of the organisation to cope should be reviewed.

7.1.5.6 Justifying the maturity level

In circumstances where the overall maturity level is unclear from the balance of different levels of process performances, the overriding CMM ethos should be applied. Previous systems of emergency management assessment have been criticised throughout the literature for being subjective and based on the opinions of consultants or individuals. In order for this framework to be fair and just and maintain the value of the CMM approach, an organisation can not be assessed at a particular level of capability and maturity unless they meet all the process requirements of that level. Without those processes requirements, the foundations of development for higher levels of operation will not be complete, and any improvement efforts would not be efficient or effective.

This approach has worked in both the CMM and PCMM applications, which have now been in use for over 13 years in hundreds of organisations worldwide. The value of the approach has been proven, and quantitative benefits of improvement have been shown in the organisations involved. This study has shown that the same approach can be applied to the assessment and improvement of emergency management.

7.1.6 Conclusions of the GEMA test in LAA

The application of GEMA was useful in confirming the utility of the model, and also valuable in revealing that with minor changes, the model could be applied beyond Major Accident Hazard Industry, in the wider field of emergency management assessment.

The Trident sequence of assessment phases was useful as an assessment structure, and was successful in drawing attention to the importance of learning in an emergency management system. The eight processes appeared to embrace all aspects of the emergency management system, and raised some novel issues and considerations with the test organisation. Some issues concerned the difference between application of the model to a private company, and application to a local government system; however a surprising level of similarity was present.

The results of the test have been discussed with the CEPO of LAA, and the conclusions and recommendations of the model were welcomed. The CEPO also welcomed the continuous improvement focus of the model as a much needed change to the current incongruity and disparity in methods across the UK emergency planning community. LAA believed that value of a continuous framework of assessment and improvement, where targets are clearly defined and the objectives are clear, was needed in the field of Local Authority emergency planning. The full implications of using the model in an organisational assessment will be discussed in more depth in Chapter 8, Discussion.

The following short section explains the process of expert validation, which was introduced in the Research Methodology, Chapter 4. In the absence of extensive testing of the model in the field, the opinions of respected industrial and academic experts was sought on the potential use and value of this approach, and their feedback on any means of improvement.

7.1.7 Expert validation review

As shown in the flow diagram Figure 4-1 and described in 4.10, the final draft of the GEMA framework was presented to a panel of academic and industry experts for their critique and feedback. The experts, whose names and affiliations are shown in Figure 4-5, were chosen for their experience and knowledge of UK Major Hazard Industry and assessment methodology. Dr Jerry Busby, a senior lecturer in Human and Engineering systems from the University of Bath was also due to attend but was called away to other urgent commitments.

The panel were sent a briefing document in advance of the meeting, which summarised the research and the objectives and proceedings of the day. The briefing document contained a short introduction to CMM and the purpose of the research, along with descriptions of the processes and assessment system. The programme for the day's discussions is contained in the Appendices. Following the presentations, the group of experts was split into two teams for the feedback session. This was to enable the researcher to compare the output and comments of the two teams, and would provide greater validity to the feedback if both groups arrived at the same conclusion.

This final section of chapter 7 will first discuss the broader scale contributions of the experts, looking at the structure of the framework and the theory behind it. This will be followed by a summary of the more specific comments and suggestions, relating to parts of processes, terminology and salient points of experience.

7.1.7.1 Structural and higher level feedback

It is important to recognise that the model shown in the Results, Chapter 6 was drawn up after the validation day, and incorporating the comments and critique of the experts. In the interests of clarity and brevity, it was not thought appropriate to include the draft model and the critique followed by the revised model, especially as there were some changes in the way the framework was structured as a result of the expert feedback.

The main structural change recommended by both groups of experts was a link between the GEMA processes and the disaster cycle's stages, which are mitigation, preparedness, response and recovery. The groups drew two diagrams, to show how they believed this might take shape. Both diagrams were essentially variations of the disaster cycle, and how this related to the various processes, and this triggered two changes in the framework.

The first change was prompted by the relationship between the disaster cycle and the opportunities for assessment in industry. The basic cycle of preparedness, response and learning reflected the stages at which this research had been assessing the organisation's capability, through the plan, the exercise and the feedback or debrief. The experts had suggested that different processes were more relevant at each of these stages. Once the process set had been changed to meet the experts other recommendations, it became clear that the same set of processes are carried out in preparedness, response and learning, achieving slightly different aims. From this, the Trident sequence was established, and the processes were further refined to prevent any overlap in the assessment. The further value to the trident sequence was that it gave a clear, three-stage focus to the assessment and also brought the 'learning' stage forward as a recognised and important aspect of the EM system.

The second change triggered by the diagrams was the notion that some of the processes were linked in a 'server-client' relationship, or the output from one process was the input to another. Following the expert feedback, this concept was explored further and the flow-diagram which shows the processes in a 'control' sequence was the result. This diagram is valuable because it illustrates to the organisation the potentially cumulative effect of allowing poor performance in one process area. While reviewing this section of the framework and the processes, it became apparent that the processes were more strongly linked at the higher levels 3 and 4. This concept will be discussed further in Chapter 8, Discussion.

The OCTO directors made three observations from their experience in Major Accident Hazard Industry which relate to the model. The first concerned the presence of Risk Analysis at the lower maturity levels. They stated that in some of the lower-performing companies they had worked with, Risk Analysis was extremely basic, if existent at all. Therefore they suggested that lower levels 1 and 2 would be better described in relation to the 'site incident potential' and hazardous context. These phrases were thought to be more representative of the organisations' levels of understanding, which was based on the actual hazard rather than the slightly more advanced appreciation of the risks that were posed. This suggestion was taken up, and the 'Risk Identification and Analysis' process was re-written to reflect this at lower levels.

The remaining observations from OCTO were that the model should try to take into account cases where an organisation may provide an excellent exercise performance, but that exercise does not truly reflect the potential

magnitude of the incident. Such cases had occurred in their experience, as there are areas of Major Hazard Industry which have never experienced the potentially serious consequences of a major emergency. This point was taken into account in terms of the Definition of requirements process, which should determine how competent an organisation must be to meet all of the requirements placed on it. Exercising is also dealt with through the training and development process, and the risk identification and analysis process.

Finally OCTO drew the attention of the panel to the value of competency-based training in emergency management. In their experience, by defining the competencies required to manage a site's risk portfolio and training the staff in those competencies, the organisation also benefited from having more competent and capable staff in its regular operations, ultimately resulting in higher productivity and a greater competitive advantage. This point has been used throughout the processes and has been labelled 'competency-crossover' in the model. It also serves another more significant purpose, which will be discussed further in Chapter 8.

Professor Sharp recalled a project to establish an assessment framework for offshore safety. The clients found that the most useful part of the report was a table describing succinctly how to move from one level of performance to a higher level. He considered that such a table would be useful in this project, to give the core requirements of moving from one maturity level to the next. The other members of the panel considered this to be a very useful addition, and after further consideration and reference to the original CMM literature, the layout of the process descriptions in Chapter 6 was changed to clearly show how improvement to the next level was possible.

7.1.7.2 Minor points and issues of definition

The first issue raised concerned the name of the framework. It was agreed by the panel that 'Emergency Management Capability Maturity Model' or EM-CMM could be considered confusing, and a more attractive name should be sought. The panel suggested the Generic Emergency Management Assessment, or GEMA, which was considered appropriate and was taken forward as the new name for the framework.

Several members of the team also suggested that as maturity level 1 did not have any performance requirements, and was simply a default level for organisations who did not achieve the formal requirements of level 2, it would make sense to re-number the levels 0-4, rather than 1-5. This would also serve the purpose of removing level 3 as a 'middle marker', which can be considered a satisfactory level of performance for an organisation that simply seeks to be adequate, rather than optimal. With levels 1-4 there is no middle marker, and organisations would be more inclined to strive for level 3 than settle for level 2. Daniel (2000) recognises this tendency within organisations and has called it 'satisfactory underperformance', which means that a person or organisation is content with a level of performance that is barely compliant and far from best practice. The panel and the researcher agreed that this re-numbering was unlikely to have any detrimental effects to the framework, and

so accepted the suggestion as being in the interests of promoting a culture of continuous improvement.

There was concern amongst the panel that the model did not make sufficient reference to redundancy and back-up plans, which are considered important factors in emergency management. After consulting the CMM literature, the study chose to incorporate the concept of 'management of change' in the qualifier statements used to assess the processes. It takes into account the ability of the organisation to deal with and respond to any change in the environment or the conditions of the response. This could include a loss of power, change of ECC venue or staff problems.

Considering the financial aspect of emergency management, the panel suggested that there be some measure of the organisations' financial commitment to the system. Rather than give this a separate process, the researcher has decided to include it as a measure of the 'Leadership and Commitment' qualifier used to measure each process. By doing this it ensures that financial commitment is assessed across each process.

On a similar theme, the panel noticed that the original PCMM had used compensation as an indicator of the organisation's commitment to its staff. This is normal to expect compensation for a member of staff's regular position; however there are no Major Hazard Industry organisations in the UK, known to the panel, which financially compensate their staff for EM duties. Some are paid over-time for attending exercises, or given the equivalent time off, but most are expected to participate in the response as a part of their role and status in the organisation. In some organisations there is often stiff competition for a place on the EMT, as it brings prestige and challenge. On this point, the panel agreed that it was correct for the GEMA framework to omit the process of compensation.

The panel concluded that a key benefit of the model was that it could also be used to assess emergency management systems outside hazardous industry, as the processes did not prescribe how they should be carried out, but explained why and left the appropriate detail and methods to the individual organisation.

7.1.7.3 Conclusions of validation review

It is rare for a research study to have the benefit of the advice from an esteemed panel of academics and practitioners. The validation review has brought a number of valuable enhancements to the framework, and it emphasises the importance of contributions from both academia and industry to multi-disciplinary areas such as emergency management.

The validation panel were convinced that with some minor adjustments, the Generic Emergency Management Assessment framework would be a useful tool, and bring a level of standardisation and accountability to the field of Major Hazard emergency management. It could also be used to assess local authority emergency planning and management systems, and has potentially wider applications regionally and nationally, considering the current changes

in the legislation and passing of the British Government's Civil Contingencies Bill, 2003. The author expresses his gratitude to the members of the validation panel for their time, encouragement and valuable contributions.

The development GEMA framework and wider concerns in this exciting and challenging field will now be discussed further in Chapter 8, Discussion.

Chapter 8

Discussion of the research process

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8 Discussion of the research process

This chapter will describe how the thesis has achieved its aim and objectives, and will discuss the research process used. An argument for the choice of methods will be presented, and the advantages of those methods over the available alternatives will be highlighted.

The chapter will go on to discuss the problems that arose throughout the research, and how they were overcome. The chapter will conclude with a discussion of the implications of this thesis with respect to the field of emergency management, and in terms of the personal development of the researcher. This will lead into chapter 9, which begins with a summary of the contribution to knowledge made by this work, and the conclusions that can be drawn from it. The thesis concludes with suggestions for further research in this subject and the wider field.

8.1 Discussing the aims of the thesis

This section 8-1 will provide an overview of the aim and objectives of this thesis and how they have been addressed. The following section will then describe in detail how each objective was achieved, and justify the choice of method.

8.1.1 Integrated learning

The literature showed that the MAHI EM field in the UK had a very limited focus on learning. Many organisations sought only to comply with their legal duties under COMAH, PSR and HASAW regulations. While regulatory standards might be enough to ensure a minimal level of response capability, they neither actively promote the development of best practice, nor encourage the organisation to develop a dynamic emergency management capability.

The development and sharing of best practice throughout the field should be a key focus of organisations, considering the lives and assets that can be at stake if an emergency is not handled effectively. A key aspect of sharing and developing best practice is the use of a common framework or vision of the field. Throughout the majority of MAHI in the UK however, differences in methods, behaviours and attitudes across the hazardous industries, sectors and individual organisations prevent any comparison or sharing of knowledge. If meaningful comparison is not possible, then the sector as a whole cannot learn from each other's mistakes, and development is retarded. Comparison between natural and technological emergencies and also across countries and regions would be very beneficial to the advancement of the field of disaster management, and ultimately save human life and assets, but it requires greater consistency in assessment and recording of knowledge and experience.

This research also aimed to establish the basis for recording and sharing examples of emergency management best-practice in UK MAHI, through a common method of assessment. The European Union's 'Framework Six' research programme is now seeking to begin research into the management of emergencies which have a trans-boundary dimension. There are several

countries tabled to join the EU in the near future, which would benefit from the experience and knowledge of UK and other longer-standing member states, to help them to meet the requirements of Seveso 2, the EU standard for MAHI emergency management. A framework that facilitates continuous improvement would be a useful tool to provide assistance to member states and industry within those countries that have to improve or change their EM standards to meet the Union requirements.

8.1.2 Risk-based, people-centred approach

The literature reviewed in Chapter 2 describes why a dynamic attitude to risk and emergency management is necessary to effectively respond in a changing risk environment. A risk basis for emergency management is also the only way an organisation can be confident that their preparedness is adequate. If emergency management is based on an estimation of the hazard, the most frequent incident or an approximation of the worst credible event then there can be little certainty that it will facilitate an adequate response to any incident.

Clarke (1999) draws our attention to 'fantasy planning', which is the production of and reliance on emergency plans by organisations and countries, despite an incomplete understanding of the hazard and the potential risk. He cites nuclear evacuation and marine oil-spills as examples of this. Daniell (2000) mentions the concept of satisfactory underperformance, which is the acceptance of a level of performance, despite the awareness that it is not sufficient to fulfil the requirements. It was apparent that there are cases of organisations that write emergency plans which meet the regulatory standard, but are not based on a complete understanding of the risk they are supposed to address. Organisations in some cases are ignorant of this risk, and in some cases use 'creative' risk assessment to minimise or discount the risk. In both cases, the plan does not relate to the actual danger it should address. By assessing an organisation's EM capability and maturity with respect to their risks and the requirements of their stakeholders, a more realistic basis for the EM system is established.

The regulator is often the only body which makes regular demands on an organisation to justify its emergency management system, apart from environmentally contentious industry, where pressure groups maintain a constant interest. The review of emergency plans revealed that it was common for organisations to become focussed on satisfying only the regulator, rather than seeking to understand and address the requirements of the wider stakeholder group. Stakeholders in MAHI commonly include the public (directly and through the media), neighbouring industry, the organisation's staff, customers, suppliers and shareholders. The emergency management system should aim to ensure that the organisation's relationship with its stakeholders is not compromised by an emergency situation.

To cite an extreme example, corporate killing legislation in the UK is fast becoming a reality. Two organisations are currently being charged for allegedly causing death, one through failing to prevent an explosion and the second through negligence which led to a train collision. The legal cases are

being brought against the organisations by the victims and representative groups, and in both cases the organisation will be asked to account for its health and safety management, and fully to justify its emergency management system. Rather than simply proving regulatory compliance, industry is also now required to prove that they are capable of managing emergency situations, and for this, a more accountable framework for emergency planning and management is required.

8.2 How those aims were addressed and the choices justified

It was important to ensure that the product of this research encouraged the development and sharing of emergency management best practice, as well as facilitated inter- and intra-industry comparison of performance and methods. To address this objective, guidance was sought from the management field, where tools have been developed to promote these aims in organisational management. In addition to this guidance from an established field, it was important to ensure that the product of this research was entirely appropriate to the UK MAHI field, and so a range of companies from the MAHI sectors were chosen as targets for the data collection.

Several methods were used to select suitable organisations and secure their collaboration. Firstly, organisations connected with the research sponsors were approached, and following that, further contact was made with organisations that were linked in some way to Cranfield University or known through contacts in the professional bodies connected with this field. Existing contact within the organisation was an important prerequisite because it is far more desirable for an observational researcher to be introduced to the group or team by an established, known and trusted contact. This concept has been described in the Methodology, Chapter 4.

MAHI is very varied, incorporating petrochemical, pharmaceutical, defence and utilities sectors. In order to ensure that the framework was appropriate to the different sites, a generic quality was required. The management model chosen as a basis for the framework is focussed on a set of processes that are deemed necessary for the organisation or system to function and improve. The organisation is assessed on the extent to which they carry out these processes, which are descriptive enough to give assessment guidelines, but not prescriptive in a particular course of action or method that might not suit all organisations or sectors.

The resulting framework could be used on any emergency management system and the output would be directly comparable in terms of those organisations' capability and maturity in the eight processes.

The framework also reflects the need for a dynamic and risk-based approach to emergency management, even at the lowest level of capability an organisation must be aware of the hazards in the context of its own site. The model states that the EMS should be based on risk, because that provides an indication of the profile of events which the organisation might have to respond to. Risk-based emergency procedures are information-rich, in terms of the extent of the consequences of particular events, resources required to

manage the incidents and likelihood of that incident occurring. The model requires that the level of demonstrated performance is commensurate with that organisation's understanding of risk.

The final objectives highlighted the need for the organisation to consider its stakeholders' requirements and to adopt a fully accountable approach to emergency management. The management model that was chosen as a guide, focussed on adopting an open approach to decision-making, which included stakeholder consultation. The model also relied heavily on performance recording and measurement at all stages, to facilitate learning and continual improvement. Such records would enable an organisation to produce an audit trail of their response, beginning with their assessment of the risk, through mitigation, planning, incident response and learning. This record could then be produced should their actions be called into question later.

The following subsections will discuss in detail how the framework was designed, and how that design was influenced and driven by the research aims. This will be followed by a section detailing the limitations of the chosen methods and research process.

8.2.1 Adapting an organisational management model

The main reason for basing the GEMA framework on an established assessment model was an attempt to transfer some of the knowledge and experience from the organisational management field into the EM domain. It was important to ensure that the framework was appropriate to the organisations and industries concerned with this research however, and this was achieved by using primary data and research to inform the fabric of the framework, drawing the range of experience and knowledge in industry. In the disaster management field it is important to ensure that that academic research has a clear application, and is tied closely to the needs and interests of the practitioners. The GEMA framework was required as a solution to an industrial problem, and so the content and focus of the model had to originate from industrial sources.

In selecting a model to form the basis for the GEMA framework, two widely used and established assessment models were examined – the Capability Maturity Model (CMM) and the Balanced Scorecard approach. The criteria for selecting models during the initial search were that the model should be proven to be effective in its own field and should also be contemporary, comprehensive and focussed on improvement and assessing processes rather than products.

From the literature, it became apparent that there was a conceptual problem with the criteria. It appeared that most existing assessment models were designed to measure a tangible output, for example number of products, profit, rate of production or a financially linked indicator of success. With EM, there is no direct tangible output. The output of an adequate emergency management system is ultimately an effective and efficient response; however such a response may never be required. The Balanced Scorecard approach (Kaplan and Norton 1996) had also been previously converted to look at

emergency management performance measurement in the EMPIRE project, (Strutt et al. 2001) but was more focussed on quantitative assessment and had not paid detailed attention to emergency planning assessment or continuous improvement.

The Software CMM (SWCMM) had previously been adapted to measure the capability and maturity of an organisation's reliability strategy, and in an offshore safety strategy assessment. It proved a robust and adaptable tool, however it was technology based, and was structured around more quantitative and tangible concepts than were present in organisational emergency management.

The solution was to use a Human Resources improvement model, called PCMM, which was based on the original CMM concept. This assessment model, as described in 3.3, is used to assess and improve the HR capability and maturity of an organisation. The benefits brought about by implementing PCMM are human-centred, process related improvements, which are closer to the requirements of EM than a profit and production based improvement model. PCMM was therefore chosen as the theoretical basis behind the GEMA framework and as a guide to determining a set of key processes to represent the EM system.

This study has indicated that there can be indirect profit and production benefits from developing staff competency in EM, as those competencies also improve their performance in their usual job. This concept of competency cross-over is discussed in 7.1.7.1 and later in this section, 8.5.

The assessment protocol of the original PCMM was however not totally compatible with the EM field. The resources and commitment required to carry out a PCMM assessment simply would not be available to assess MAHI emergency management. In nearly all cases the EM role is secondary to a member of staff's usual role on the plant, and so requesting that members of staff were available for structured interviews, focus groups and surveys would not be acceptable, as it would entail replacing those staff on the plant, and incurring extra costs. At an early stage it became apparent that any assessment framework must not place excessive resource demands on the target organisation, and must, as far as practicable, use existing structures and events to collect data.

The framework was therefore designed to use data from the emergency planning documents, which would be available for examination without additional resource commitment from the organisation. Secondly data would be collected by observing exercise simulation and observation and interaction within feedback sessions, both of which take place regularly as a legal obligation and also for training purposes. This resource neutral approach to assessment has been welcomed by representatives of MAHI who have been informed of the concept.

8.2.2 Collection of data within organisations

The three data collection methods were employed to give as wider understanding of the processes involved in emergency management systems as possible. It was only by visiting a site, examining emergency planning documents and observing an exercise and the learning that follows it, could an overview of a typical emergency management system be developed.

In this research a separate set of emergency plans was used in the data collection. This was because the plans and documents examined before the exercises, with a few exceptions, were not of sufficient descriptive standard to provide the necessary information to build the framework of processes. It was very important to base the process set on as wider range of planning and exercising examples as possible. While the observed exercises provided a good range from poor to comfortably adequate, the site-plans were mostly site-specific interpretations of the regulatory requirements, and as such were very similar. It was therefore necessary to look at a set of off-site emergency plans, which gave a greater scope for detail on the integration and collaborative aspirations of the organisations. Accordingly the off-site plans exhibited a much better range of standards, from excellent to operationally useless.

As a result of this experience, the protocol for conducting a GEMA recommends that all appropriate documents, which includes the site and off-site plan, are examined for evidence of key processes.

There was also a conceptual reason for assessing at all of the three stages of preparedness, response and learning. A criticism of previous EM assessment methods was that they had usually focussed on the emergency exercise as the main assessment indicator, often taking a cursory look at the emergency plan for confirmation of its existence and evidence of regulatory compliance. This type of assessment, as described in the Introduction (Chapter 1), gives a view of the organisation's performance at that particular time, and with that particular scenario. Evidence of performance in one specific emergency exercise cannot however be taken as evidence of its capability to perform in any future incident.

The more robust approach is offered by the CMM genre. It involves assessing the organisation's implementation of a set of processes, which together indicate how the organisation has achieved its current level of capability, whether it has done so in a sustainable manner, and how it should proceed to ensure continuous improvement. Capability assessment shows where the organisation is at one point in time, and maturity assessment strengthens this by investigating the organisation's current maturity level, how it achieved that capability, and what it should do to improve.

This concept was translated to the EM field by ensuring that the processes looked at the risk-basis of the EM system. A strong basis was interpreted as being based on risk analysis and an understanding of stakeholder-requirements. The sustainability of the EM system was related to maintaining the HR issues and the resources to facilitate a response. The prospect for

future capacity was defined by the extent to which the organisation incorporated learning and innovation at every level of its system.

Using three separate means of collecting data can also reduce the chance of an organisation being able to 'fake' a good performance. It is possible, and has been experienced in this research, for an organisation to ensure that its most highly trained and experienced EM personnel are exhibited in an exercise of which they have been given advanced notice, and the standard of which is not as challenging as their site risk could demand. This type of exercise can be obvious to the assessor however, if they are familiar with the site hazards, EM documentation and have been briefed on the staffing of the EMT. The authors of the original CMM commented that written evidence presented for assessment must be accepted as truthful, as an organisation that is committed to the assessment process and to continuous improvement must be considered to be generally honest and open with the assessors. Toft and Reynolds (1994: 16) cite Brown and Sime who discuss qualitative research interview response, and suggest that

"...in the absence of any evidence to contradict what the respondents profess to be the case, it should be assumed that they are not deliberately lying or distorting the 'facts' as these appear to themselves"

(Toft and Reynolds 1994: 16)

It is also important at this stage to reiterate the distinction between different types of exercise, and their suitability for assessment purposes. An exercise can be used to test the emergency plan, train staff or demonstrate capability. It is important that an assessment takes the exercise purpose into account. An exercise to test the emergency plan and procedures will illustrate failures in this area, and may lead to the ultimate failure of the response. It can provide useful observation data, as it should demonstrate the organisation's learning capacity.

Likewise, an exercise to train the EMT will highlight deficiencies in their knowledge and abilities. Improving that knowledge and enhancing their abilities is the purpose of the exercise, so it can demonstrate that the organisation has an advanced appreciation of the need to learn. Training exercises indicate commitment from senior and operational staff, and an organisational recognition of the importance of emergency management, the need to train and the need to exercise to improve and verify that training.

Finally a demonstration exercise indicates that the organisation has a plan and trained team in place, and is willing to exhibit their capability. The exercise should directly indicate the effectiveness of the EMT training, the adequacy of the emergency plan and the adequacy of available resources. It could also indirectly indicate the organisation's level of risk appreciation by the scenario that they use and the commitment of the organisation to improvement, by the way in which the exercise is approached and carried out.

It was important to undertake basic level research methods and training before carrying out the observation part of the data collection, and the knowledge and techniques learned in those sessions served the researcher's

objectives well. Advanced knowledge of psychology and research methods would be required to design implement and analyse surveys, focus groups and structured interviews, and so the Trident sequence of plan, exercise and feedback assessment was chosen as being the core data gathering means to inform the framework.

When the data were analysed, the sets of plan and exercise data showed a reassuring level of homogeneity. It was also a convincing indication that a suitable range of practice had been used to inform the fabric of the framework, and that wider sampling or a further method of analysis and clarification would not be required. It is recognised however that the prescriptive nature of the COMAH regulations (HSE 1999) meant that the lower level of the data was quite uniform in its compliance, but there was also a significant number of examples which performed to varying degrees in excess of compliance. While the lower limit of the data appeared to be set at compliance, there was considerable variation in the organisations that exceeded the regulatory requirements.

8.2.3 Application and review of the GEMA framework

The final area of the research methodology which requires justification is the exposure of the framework to testing and validation. At the beginning of the project at least one full-scale test of the framework within MAHI was seen as being a valuable indication of GEMA's use and value as an assessment method.

By the time the research had reached an appropriate stage to plan this test, the climate of collaboration and hospitality previously experienced in MAHI had been changed by world and local events. The security repercussions of September 11th 2001 had caused many of the MAHI organisations to restrict access to their sites to all but essential visitors, and upgrade emergency planning documents to a higher level of privacy. The UK Fire Service was also engaged in a period of industrial action during 2002-3 which resulted in only essential fire cover being provided by the military, and many of the MAHI sites being prevented from holding their major exercises due to lack of back-up cover.

The alternative solution was to test the model in a different type of organisation. A contact within one of the professional societies for this field invited the researcher to attend a large multi-agency exercise, in which Local Authority 'A' (LAA) was playing a major role. This seemed a good opportunity to test the model, as the exercise, plan and feedback stages would all be accessible. Permission to carry out the test was granted by LAA and the assessment went ahead as described in Chapter 7.

The full implications of the test are shown in Chapter 7. In conclusion, the test was very successful in the sense that evidence of all 8 of the GEMA processes was found in the data, along with indicators of how each process was being carried out in line with the qualifying statements. It was necessary to clarify the meaning of the qualifying statement 'Evidence of verification and the management of change', as this was initially difficult to assess. Verification

evidence refers to any evidence other than the source currently being assessed, so if examining the exercise, that part of a process would be verified if evidence was also seen in the emergency plan, or in other evidence. Management of change refers to the ability of the organisation to still carry out that process if something changes. The loss of electrical power, absence of a team member or climatic change could be examples of this.

There was a major advantage of testing the framework in a different type of organisation than had been used in its design. This test would not only show that the processes and framework functioned as intended, but would also indicate the viability of using the framework to assess EM systems outside MAHI. The framework did perform as expected, and the results were encouraging. Wider application of the framework will be discussed later in Chapter 9, Conclusions and suggestions for further research.

Although LAA were disappointed that they did not achieve maturity level 3, their overall maturity level of 2 compares very well with general CMM performance of industry reported in the literature. Certainly none of the other organisations involved in this research would have been likely to show evidence of maturity above level 2, from a cursory examination of the data.

A large survey of maturity levels of the organisations that have been assessed for the CMM framework gives some indication of the maturity of the software industry as a whole. SEI data indicates that 75% of organisations assessed with SW-CMM (Paulk et al. 1995) are categorised at level one (GEMA level 0) – the ad hoc, initial unstructured state of maturity. Success of the organisation at this level is entirely dependent on skills of individuals to deal with problems and manage solutions. 15% of organisations are placed at level two (GEMA level 1), which shows they are disciplined and have repeatable processes. Planning and managing of new projects is based on previous experience of similar projects.

Level three (GEMA level 2) is home to 8% of organisations, whose processes are defined and consistent. There is a standard, documented means of developing and maintaining software which is used throughout the organisation. Only 1.5% of assessed organisations reach level four (GEMA level 3), where their software process and products are quantifiable and predictable. It is monitored to operate within these quantitative limits. Quantitative goals for productivity and quality are set, measured and changes implemented. A meagre 0.5% of organisations achieve level five (GEMA level 4), which dictates that they must be continuously improving their processes and products. Identification of weakness and strengthening of processes must happen proactively at this level and prevention of defects is the common and overriding goal (Paulk et al. 1995).

8.3 Limitations of the chosen methods

This section will explore the boundaries and limitations of the chosen research methods.

8.3.1 Ethical considerations in emergency exercises

While it is recognised that exercises should represent a realistic simulation of an emergency, there are limits beyond which that realism should not extend. There has been a wealth of psychological research carried out on stress and trauma on how it affects performance of individuals. Hodgkinson and Stewart (1995) present straightforward discussion of the planning and response implications for reducing stress and trauma. There is an argument that exposure to stress in an exercise reduces stress in a real incident, but this is countered by the knowledge of PTSD, a clinical condition which results from repeated exposure to stressful situations. The important limitation was that although the researcher had no control over the scenario and how it was conducted, the University's ethical guidelines for qualitative research demand that an intervention should be made if any participant were placed under a dangerous level of stress. Happily there was no such occurrence, and the exercises did not attempt to recreate the stress of an emergency situation.

One of the difficulties was sanitising the data to a sufficient extent to make it unlikely that any of the participating organisations could be identified. Many of the sites could have been identified by their building names, the names of members of the EMT, date of the exercise or the chemicals and processes involved. All of this information had to be standardised in the data, to respect the confidentiality required by the companies involved.

8.3.2 Method and reliability of sampling

It could be argued that the sample of organisations involved in the research was skewed, as they all either worked with OCTO Ltd, the research sponsor, or had a link to Cranfield University or one of the professional societies or groups interested in the EM field. This involvement indicates that they are predisposed to be interested in EM improvement, and so the research only used examples of organisations that were already improving, and so the group of organisations that had a poor system and were unwilling to change was not represented.

This limitation can be answered with several points. Firstly, any organisation that has no interest in improvement or development of their EM system is unlikely to agree to participate in research on that subject, so efforts to recruit those in the lower end of the maturity range would be likely to fail. Secondly the Data Analysis shows that in the analysis of the plans and exercises, the processes which were identified with greatest frequency in the sample of *keen* organisations were the low maturity processes, and there were few higher maturity processes identified in the sample. This suggests that even if efforts to involve a greater number of less enthusiastic organisations had been successful, it is unlikely that they would have added a great deal of value, as they would be probably only show evidence of levels 0 or 1.

A further limitation to the scope of the sample was the resources available for this project. The propensity of MAHI to hold exercises over the winter season limited the number of exercises that could be observed in one year. Each visit took up to three days, including travel to and from the site. This was

compounded by the previously mentioned difficulties in 2001-2 which brought an unexpectedly sharp end to the access to some sites.

Carthey (1998) trained and employed a team of observers to assist in her research in nuclear EM control rooms. Her work was concerned with communication, and so extra observers could observe individuals in the response and compile their observations to construct a map of the incident communications. This research was concerned with wider process-based observations, and so an increased number of observers might not directly increase the reliability of the conclusions, as it is far more subjective than recording a conversation between two people. Secondly, a greater number of observers would have been impractical at most of the sites, as the ECC was not large enough to accommodate more than one observer without inconveniencing the EMT and causing unnecessary disruption to the exercise.

In large response systems, such as the Local Authority emergency response, there could be merit in observing the response at the different levels of operations, known as gold, silver and bronze. On a small hazardous site however, one could gain little additional information from observing three fire operatives simulating the extinction of a fire.

The effect of the observer's presence on the members of the EMT can not be discounted in the exercises. The Hawthorne experiments were carried out at the Western Electric Company, USA by Harvard Business School researchers between 1924 and 1932. The researcher credited with the main contributions from these experiments was Elton Mayo (Mullins 1996: 50). One of the discoveries was that if management or another body paid increased attention to the workers in the plant, their rate of productivity increased. The experiment was designed to test the effect of changes in the workers environment to increase productivity. The productivity of all the groups, including the experimental control groups where there had been no environmental change, increased, and the effect of observation was identified as the causal factor.

In the emergency exercises, the observer usually occupied a corner of the room from where they can see and hear the key aspects of the response. They could not however observe from a remote location, and no matter how discrete, the EMT are aware of their presence and have been introduced and briefed on the purpose of their visit. There were a number of EMT members who said during the feedback that they were a little more nervous because they were being observed; however in the fast-moving atmosphere of the exercise it is not expected that the presence of the observers had a serious impact on EMT behaviour.

Lyons (2002) recommended video recording of exercises to allow full transcription. This may be practical on smaller sites, but this research has found that on larger sites the effort would outweigh the value. For research which is exploring the role and function of an individual in an emergency, then a transcript of their actions would be essential. For organisational or system-based research, such a level of detail is not desirable and would require an unnatural and intrusive level of recording technology in the ECC. Video

cameras and sound equipment, along with the necessary tasks of adjusting them, turning on and off and repositioning would detract from the high level of realism that is desirable in an exercise. Validating the experience of limitations discussed above, Carthey (1998) also discussed the problems of field research in emergency exercises, and highlighted four key limitations as

- *How to develop a data collection method that allowed data to be collected in a robust and consistent manner.*
- *The researcher being unable to control certain variables, most importantly, the exercise scenario*
- *Fitting the research aim and resources together,*
- *Ensuring consistency and controlling for subjectivity in the analysis of the data.*

Carthey (1998)

Carthey concludes by suggesting that research based in the emergency control room does not capture the complexity of the nuclear EM process, and there is a niche for research which takes a more organisational perspective on the accident management process.

8.4 Problems encountered and overcome

This section presents a discussion of the problems encountered in this research. They are divided into two groups. The research and subject related problems are dealt with first, followed by the personal development issues and achievements.

8.4.1 Research and subject problems

An initial problem related to the research and theory behind the original CMM. The capability maturity concept had been designed intuitively, rather than based on any solid research method or data, so it was not possible simply to go back to the original research and understand how the processes were designed, or how the levels were structured and compiled, as it was all based on ideas and theory, not data. Although this raises questions about the basis for the model, the results from the implementation of CMM indicate that even although the concept is not grounded in data and research, it actually works well.

A survey of organisations that have used SWCMM and implemented change, SEI (Paulk et al. 1993) has shown quantified improvement in the performance of those organisations. Their analysis shows that when organisation moves from maturity level one to level three (GEMA level 0-2), their ability to meet schedules improves from 32% to 80% and the perception that their product quality is good or excellent improves from 64% to 100%.

A second problem with the original model was that it was written using language that is common amongst management professionals in the USA, but somewhat wordy and jargon-rich to everyone else. Changes to the language of the framework had to be carefully considered to make it appropriate to a new field without altering the meaning of the levels, processes and requirements. These language changes were carried out in discussion with a

number of research colleagues, and went through a great number of revisions before arriving at the GEMA terminology in Chapter 6, the Results.

8.4.2 Data collection challenges

There were a number of problems in collecting consistent and robust data in exercises, as there was little standardisation and many factors carried out differently on individual sites. The chemicals and manufacturing processes on most sites were different, and so a whole language of acronyms had to be learned for each exercise, and replaced before visiting the next site. It was also challenging to assimilate the functions of the site, the hazards and the response in time to fully document a live exercise and ask any clarification questions. This also had to be carried out within the short space of time available with the organisation. If the research were to be carried out again, one recommendation would be a wider sample of exercises and even the use of documented exercises from the past, to spread the burden more evenly over the time available, and allow time to study the site and documents in greater depth before observing an exercise.

A further problem in the exercises was that the researcher had no input into the design or running of the simulation. Most of the organisations who participated provided well written and challenging scenarios, which resulted in a high level of realism. Each exercise was however unique, which did not make it easy to carry out any sort comparison. As discussed previously, there was no guarantee that staff had not been pre-warned or briefed on the contents of the scenario, or whether the EMT on the day was made up of the most competent and experienced staff in the organisation. Although it was mentioned above that the efforts of sites should be taken as genuine, most of the exercises were conducted primarily as inspection opportunities for the regulator, and so there is a clear incentive to present a smooth and problem-free performance.

The researcher also encountered the problem that there was not a great deal of academic literature on emergency planning and emergency management systems. There was a significant quantity of material presenting anecdotal comment from practitioners, especially from the United States, and from emergency services personnel. Apart from a small number of key texts on emergency management and lessons from industrial disasters, most of the remaining work was case-study based, examining one particular incident. There was however some excellent analysis found in the official inquiries to UK disasters, despite the reports themselves being rather lengthy and written in pseudo-legal format.

The literature which was written by EU bodies was by far the longest, and often super-strategic in nature. EU documents were mainly focussed on environmental factors, and there was a lot of material that was specific to certain chemicals. Undergraduate level study in Disaster Management had taught the researcher that often, very good disaster management papers are written by specialists in other fields whose subject impinges on disasters and emergencies, and so a wide trawl through unlikely journals harvested a number of interesting and valuable papers.

From the search and study of other UK doctoral research in this area, it was found that the majority of work has also been carried out by individuals with a specialist background in other areas, such as psychology, natural hazards, engineering, computing or politics who have looked at a disaster related problem in the context of their field. This unfortunately meant that there was also little guidance from the literature on appropriate methodology to use for this research. There is very little work at this level which has been approached from a multi-disciplinary perspective, which is one of the novel contributions of this thesis.

8.4.3 Personal development issues and achievements

There was ongoing challenge of choosing an area of research from the large number of demands throughout the field. The subjects of risk and emergency management both offered a wide choice of potential research topics, and a number of them were briefly investigated but later abandoned. These included the study of the comparative success of different methods of rescue from the sea, and risk assessment and emergency planning for underground transport systems. These are discussed further in section 9.3.3.

One personal achievement from this research was overcoming the tendency to look for perfection in a subject that is at times, by its very nature, chaotic. Later in the research it became apparent that no matter how perfect the model, well trained the team or how well equipped the site, there can always be an unexpected event or a 'beyond design basis accident' which would push any EM system beyond its limits. When challenged on the purpose of emergency management, and the reason for this research it is now clear that the risk term 'ALARP' is not a negative excuse for failing to plan or prepare or manage risks, it is an upper limit of investment and commitment to ensuring that the organisation use all possible resources to do everything practicable to limit and reduce risk.

The importance of preparedness as a researcher was also highlighted by this study. All of the emergency exercises studied were unrepeatable, single events with one chance to record the valuable data. It was essential that the researcher was well prepared and briefed in order to appreciate the events and features of the scenario. A full awareness of the site processes and EM system structure was crucial, and in the exercise a full transcript of events was kept, with as much extra detail and photographic evidence as possible recorded. A useful rule throughout the data collection was that if one has too much information, some can be deleted; however if one has too little, there is no way to go back and collect it again.

The researcher has also learned the importance of professionalism when carrying out research with any collaborators, industrial or governmental. As an academic in an industrial environment some people assumed that we should know all the answers, and it is far better to admit that we do not know, than claim knowledge and expertise we do not have. It has been the researcher's experience in emergency management that industry and practitioners welcome academic input as a means of recording, consolidating and structuring the vast amount of knowledge and experience they have.

Especially in this field, it has been vital to appreciate the value of interdisciplinary work and seeking the best aspects of other fields and systems, and designing ways of making them appropriate and useful in the chosen issue.

The task of observing people in exercises was also challenging and one which taught the researcher a lot. The difficulties are in keeping an impartial record of the proceedings, and not allowing oneself to be influenced by those who spoke louder, appeared to be busy and involved in the scenario or asked the most questions. Often in the emergency response it was the members who were standing back from the table, thinking and reflecting quietly who had the more important contributions to make with a few choice words. The skill in observation was to record as much of the scenario as possible, and interpret which parts were more influential with hindsight, when analysing the data at a later stage. The louder members of the team, or those who appeared to be always busy were usually not working effectively, and not able to handle the situation in a calm, reflective manner which is required in intense, stressful situations. This was clarified in the feedback, when it emerged that such characters are generally unaware of the wider strategic picture, and so unable to adapt their contribution to it.

8.5 Implications and value of the research

This research has met several recommendations and objectives set out by other authors throughout the subject literature. These implications of the research study are outlined in the following section. Many of these points were raised initially in the literature review, Chapter 2 and full discussion of the context of each recommendation can be found there.

Alexander (2002b) recommended that some of the well researched and developed organisational management theory be applied to the study of disaster and emergency management. The CMM has a proven success rate in organisational improvement, and this study has shown through the use of the CMM principals and structure, that management theory is transferable to improve EM practice, so long adequate attention is paid to the issues of language, context and focus.

Clarke (1999) found that some emergency plans are based on crude estimation and the manipulation of inappropriate data to achieve a convincing response plan. The fact that the plan could never be effective in the occurrence of the real threat was rarely realised by the authors of the plan, but they were equally ignorant of the consequences of their actions or the severity of the threat. Clarke recommended that all emergency plans should have a risk-basis and high level of accountability to their stakeholders, which is met by the GEMA framework through the inclusion of the key processes 'risk identification and analysis' and 'Definition of requirements', and the GEMA focus on the risk control diagram that links processes at all levels of emergency management.

Use of the GEMA framework enables organisations working in separate societies and sectors to compare aspects of their response capability, and

learn from each others' experience. This desirable advance was alluded to in the work of Beck (2001), who described the concept of a world risk society, in which many different groups were suffering from the same risks in different environments, and with differing levels of ability to cope. Such comparison of EM systems between countries and cultures might enable resource poor societies to learn the lessons of accidents without having to suffer the costs and consequences, which are invariably higher when coping ability is low (as discussed in 2.2).

Douglas and Wildavsky (1983), Pidgeon (1998) and Renn (1998) discuss the merits of public participation in risk management and liaison between the bodies which are responsible for the risk, and the people who could suffer the consequences of the risk. The GEMA processes of 'Definition of requirements' and 'Response Assurance', described in 6.3.2 highlight why this level of interaction is necessary, and link it closely with the other processes in the framework.

In a similar trend, Alexander states that

"...the emergency planner should first and foremost strive to create an environment in which people can work constructively together in a state of mutual understanding and collaboration. This is the key to solving the disasters problem."

Alexander (2002b: 304)

This attitude of constructive dialogue and understanding is important to the response assurance process, and the achievement of collaboration to a scale recommended by Alexander would indicate a high level performance in the GEMA framework.

Turner and Pidgeon (1997) agree with the original theory that prompted the conception of the CMM. They state that management edict and external regulation can not bring about permanent organisational learning or cultural change, and such change can only be brought about by the long term process of self-design. CMM was conceived because of the repeated failure of management fashions and fads, which were imposed on organisations and failed to have any improvement effect. Continual, structured development was seen as the way forward, and that ethos began CMM, discussed in 3.2.

Turner and Pidgeon (1997) also quote Douglas (1992), whose argument makes it clear that blame must be avoided if there is to be any significant learning from an accident or incident. The GEMA does not seek to attribute blame or fault for the cause of any incident, although it confirms that it is the responsibility of the organisation to identify the causal factors and trigger events for any incident, in order to learn from the mechanisms of failure.

Finally, Turner and Pidgeon (1997) state that a 'good' safety culture might both reflect and be promoted by at least four facets;

- *Senior management commitment to safety*
- *Shared care and concern for hazard and solicitude over their impacts upon people*
- *Realistic and flexible norms and rules about hazards*
- *and continual reflection upon practice through monitoring, analysis and feedback systems.*

(Turner & Pidgeon 1997: 188)

All of these four facets are all found in the GEMA framework. Each process is examined on the strength of the leadership and commitment evident in carrying it out. Concern for the hazard and care over the impacts it might have, is reflected in the processes of Risk identification and assessment, and also the response assurance process. The Definition of Requirements process and the Risk Identification and Analysis process ensures that the norms and rules are realistic, and the model itself aspires to creating a flexible EM system and response, by ensuring that there is 'continual reflection' on practice, using monitoring, feedback and analysis systems.

The final chapter of this thesis will clarify the original contribution this thesis has made to the scientific field, distil a set of conclusions that can be drawn from the study, and offer suggestions of how this work can be used as a basis for future wider research.

Chapter 9

Conclusions and suggestions for further research

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9 Conclusions and suggestions for further research

9.1 Contribution to knowledge

As a Doctoral thesis, this research must make a clear and significant contribution to scientific knowledge.

The significant contribution to knowledge from this research has been to take an established model from one field and adapt it to make it suitable for use in a novel situation.

The People Capability Maturity Model has been widely used for a number of years to assess the maturity and capability of an organisation's workforce. It adopts a process-based, continuous improvement focus and aims to create a workforce that is continually optimising, and adapting to respond to new situations.

The structure of the model was adapted by using original data from the emergency management field to build a new set of key processes. These processes represent what an organisation must accomplish to create an emergency response. The language and the practical assessment protocol of the model were adapted to make them suitable for use in a new field, and across a number of different sectors where emergency management is carried out.

A test assessment using the model was conducted, in which the researcher gathered data from an organisation's emergency documents and plan, at a live emergency exercise and during the exercise feedback and learning sessions. These data were analysed using the draft model and conclusions were drawn with relation to that organisation's capability and maturity in emergency management. The structure of the model enabled the researcher to identify which of the organisation's processes required improvement, and which stage of the emergency management cycle required the greatest attention.

The new model was finally discussed with a panel of industrial and academic specialists from the field of emergency management in the UK, and their opinions and feedback on the structure and applicability of the model were sought. Refinements were accordingly made, and the model is now ready for further, large scale testing and application in the field.

Additional contributions that this research has made include the assessment of an organisation's risk analysis and management process as an indicator of their emergency management capability. The research showed that a risk-basis for emergency management is an important determining factor in the sustainability and resilience of their system. The process set incorporates Risk Identification and Analysis, and shows how a risk-basis provides the foundation for the other processes in the framework.

The development of the GEMA framework is also the first time a maturity assessment approach has been applied to Major Accident Hazard Industry emergency management. Maturity assessment examines how the system has been developed, how it is currently performing and how it learns and is likely to develop in the future. From this information the assessment can indicate how the system is likely to develop, and what improvements are required to reach a higher level of capability.

Finally, the GEMA framework provides a generic assessment basis through which dissimilar industrial organisations can compare their emergency management capability. The framework is process based, and so the assessment is the same, irrespective of the final scale, type and nature of the emergency response. Such comparison and benchmarking capability could encourage the sharing of information and learning throughout UK hazardous industry and the associated agencies.

In addition to its contribution to knowledge, the study also satisfies the aspirations of applied research, defined by Patton (1990) as

“...Improve practice in industry by identifying more efficient ways of doing things”.
(Patton 1990: 197)

It is intended that by following the GEMA framework and the improvement guidelines that result from an assessment, an organisation can achieve more efficient and effective emergency management.

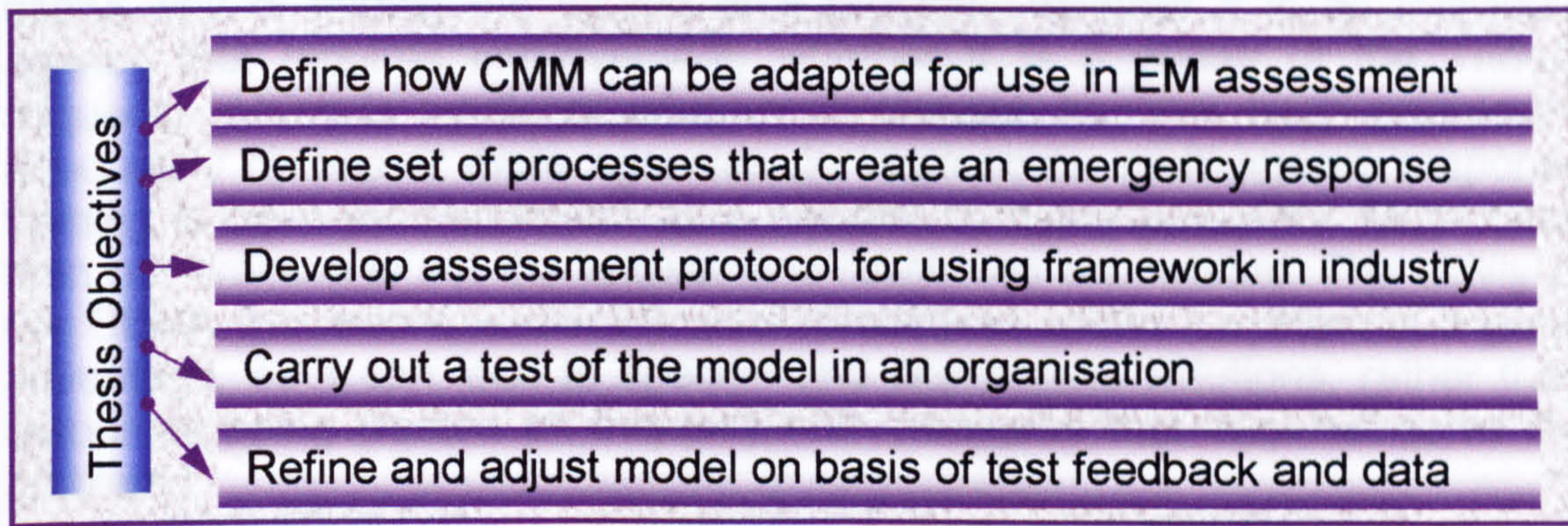
9.2 Conclusions

The conclusions will begin by discussing the extent to which the research has met its original objectives, before going on to make further conclusions based on the design and testing of the GEMA framework and the general data gathered in this study.

9.2.1 Achievement of the aim and objectives

The aim of the thesis was to develop a risk-based, continuous improvement framework for the assessment of capability and maturity in emergency management systems. The data was collected from collaborating organisations within the UK Major Accident Hazard Industry. The model was intended to assess the organisation's current emergency management capability and also provide structured improvement guidance. The model was also required to have should have a people-focussed approach. The objectives are summarised in Figure 9-1.

Figure 9-1 Summary of thesis objectives.



The Results of the data analysis, Chapter 6, shows clearly how the first three objectives of the thesis have been achieved, and a thorough explanation of how this was carried out has been presented in Chapter 8, the Discussion of the research process. The test of the model met with some initial difficulties, and it was not possible to test the model in the same environment that was used for the data collection. The model was however tested in a Local Authority emergency management system, which gave the additional advantage of testing the generic nature of the GEMA framework. The test was conducted successfully and the results are presented in full in Chapter 7, Application of the framework. The model was then subjected to a final test, which involved seeking a critique of the framework from a panel of industry and academics with expert knowledge of the emergency management field. This test also yielded satisfying results, and the refinements that arose both from the test and the panel exposure were made to give a final version of the model, presented in Chapter 6, Results of the Data Analysis.

From the evidence, the objectives of the thesis have been met in full, and this section can now make conclusions from the research.

9.2.2 The use of GEMA in different organisations

The GEMA framework has been designed to assess EM capability and maturity in MAHIs and has been tested on a LA emergency management system. It has shown that the model provides useful and important information of the weaknesses and strengths of those emergency management systems, and gives a structured indication of how the system can be improved.

The framework is generic, as it focuses on the processes an organisation uses to develop its emergency management system, rather than the type and nature of the specific response. This generic quality allows assessments of dissimilar industries to be compared, and inter-sector as well as intra-industry sharing of lessons and knowledge. This potential extension of the learning throughout the Major Hazard operators can only have positive effects in reducing the number of common-cause failures and emergencies that occur across the UK.

The GEMA framework could also be applied to each organisation in a multi-agency response. This would indicate any weaknesses in the overall coordination of the response, and identify areas for joint or shared

improvement between collaborating agencies. Joint response overview is a useful way of finding the source of a problem, whether it is an individual agency that requires improvement, whether it is a phase of the Trident sequence which is weak, or whether a process has not been addressed adequately by one or more agencies. In large scale, multi-agency response training is often recommended as a solution to many problems. More often than not, training is not the answer and resources are wasted. The ability of the GEMA framework to identify weak processes within a system is a great advantage, as it can lead to specific and appropriate solutions, rather than resources being wasted on inappropriate measures that may not solve the problem.

9.2.3 Benefits of improved emergency management capability

The higher levels of the GEMA framework require a competency-based approach to emergency management training and development, and an integrated approach to the human resource management, organisational learning and research and innovation processes. If developed and improved in the context of emergency management, these processes could also have a positive impact on how similar processes are carried out in the regular business of the organisation. This can be especially true in the case of competency development. Anecdotal evidence was provided by the research sponsors of the proven benefit of competency development on individuals and teams. It not only improves their ability to carry out their emergency management role, but also his or her ability to fulfil the requirements of their usual jobs. This competency-crossover could be a way of quantifying a tangible benefit of improving emergency management.

The formalising of an emergency management human resources process was an important step in recognising the value of people within an emergency management system. There should be no reason why an individual's emergency management role should not be treated in the same way as his or her usual job in terms of selection, qualification, development and promotion. In a similar respect, their occupational health and safety concerns should also be formally addressed within the context of their emergency management role. They should also be clearly informed of the legal implications of their actions in their emergency role, and their legal responsibility and liability (if any) for actions taken during emergency response. Continual development of their role, involving mentoring, additional education and accreditation and promotion should also be addressed in a similar fashion as their usual position in the organisation. PCMM has proven that these factors positively influence the performance, satisfaction and reliability of an individual within an organisation, and so one could expect that similar benefits will be realised if these human factors are taken into account in emergency management.

The highest level of maturity in the GEMA framework also embraces this concept of narrowing the gap between regular organisational management processes, and emergency management processes. The narrower that gap is, the easier, quicker and more efficiently an organisation is able to respond to fluctuations or trigger events that could lead to an emergency situation. Gaining control of such events reduces the likelihood of an incident occurring,

and reduces the disruption to organisation's regular business. In a level four organisation which optimising and adaptable, emergencies are stopped before they occur, and they appear as minor disturbances with little or no consequence to the organisation or the wider stakeholders.

Finally, the adaptation of the GEMA framework from the PCMM has shown that research and models developed in the organisational management field have the potential to be adapted for effective use in the emergency management sector. This issue will be explored further in the following section, with the ultimate hope that further research will be carried out on the use of other management models and principals to the ultimate benefit of the emergency management field.

9.3 Suggestions for further research

9.3.1 Further work on this concept and contribution

The GEMA framework follows the PCMM endorsement of competency-based training and development. There has been insufficient time in this research however to fully explore the concept of emergency management competency. As mentioned earlier, accreditation of emergency managers is a matter being driven forward by the UK Institute of Emergency Managers, and this valuable work will no-doubt call for further research to define and measure the competencies necessary for emergency management. This is another area that could benefit from research already carried out in the management and management psychology fields, and should be more thoroughly investigated. Examples of competencies which have been identified through the data collection in this research include:

- Communication
- Information management & analysis
- Leadership
- Teamwork
- Dealing with pressure
- Decision-making
- Negotiation and conflict resolution.

The GEMA framework, in a similar way as the PCMM, is designed for implementation by a professional with knowledge and experience of emergency management systems. It could however be adapted into a self assessment programme, which once introduced into the organisation could provide an ongoing database which can be built and used to record and log improvement against targets. Such a self-assessment programme would require a software basis to enable the user to enter and retrieve information, and enable the computer to compare the data entered with the inbuilt set of rules, conditions and examples that identified each process set. The advantage of such a system is that the organisation can adapt elements of the framework to reflect their situation and achievements more accurately, whilst maintaining the generic capability at a higher level. Further testing of the model in an industrial setting, and longer term collaboration and development with a small sample of organisations would be necessary to define the scope and value of such a project.

As a continuation of this study, the framework would benefit from reassessing some of the organisations that had participated in the research back in 1999-2001. The collaborators did not receive individual improvement feedback from the final model, as there were very few organisations that contributed data to all three stages of the Trident sequence for an assessment. Such reassessment would identify how emergency management systems develop without CMM-type intervention, and would provide a useful baseline against which to judge the future impact of the model.

Finally, the generic capability of the framework would be tested thoroughly if it were applied to a MAHI organisation operating in a different culture and society within, or outside Europe. The CMM and PCMM methodologies have been proven to be effective in organisations round the world, however it would be valuable to conduct research to establish if the basic principals of the GEMA processes take place to a similar or lesser scale in organisations where the society is less affluent than the UK and USA, or has different standards of behaviour and work ethics. If it was found that the basic principles still apply, then the GEMA framework could be used as a tool in newly industrialising countries, to develop their industrial emergency management capability from a low level.

9.3.2 Further work in the field of Major Hazard EM

Although the model was tested in one Local Authority emergency planning department, the standard exhibited was by no means representative of the field. This conclusion can be supported by the data collected from LA emergency plans and analysed in Chapter 5. Further testing in other LA systems would show how appropriate the framework was, and the value of carrying out the assessment. There should also be some consideration here of the newly established regional operations established by the Civil Contingencies Secretariat. Their full remit is not yet clear, however if it involves the coordination and standardisation of regional efforts in multi-agency emergency response, this could be a potential application for the GEMA framework. Further research would have to be conducted on the level of response and planning, however the application to this new development appears promising from the outset.

Recent world events have illustrated the importance of response phase decision-making in major emergencies. This is especially relevant in response to terrorism, where secondary hazards are likely to exist and compromise the safety of the responders. Recognising the model used in GEMA to illustrate how processes interact at the different stages of the Trident sequence, further research should be undertaken to explore exactly how process development in the preparedness stage influences the undertaking of that process in the response stage. Clearly there are advantages to developing process capability in the preparedness phase, where time is available and there is no immediate threat. This then could improve process capability in the response stage, where timely, considered actions are essential to control the situation and prevent escalation.

9.3.3 Further work on wider Emergency Management Issues

Various projects have been undertaken during the researcher's registration period, some of which were abandoned in the proposal stage due to lack of funding or collaboration. Some of these pre-proposal projects highlighted interesting areas for further research in the field, and possible applications for the methodology developed in this thesis.

A large volume of data is collected each year in the UK and overseas, by coastguards and lifeboat groups, detailing the rescues in offshore and inshore waters. Some of the data are given basic statistical analysis, but little further work is carried out. Some of the current standards and norms for rescue at sea are based on very old data from military experiments. There were recently proposed changes in the ways that offshore platforms respond to rescues at sea, including changes in the use of helicopters and fast-rescue craft in addition to personal distress beacons and sensor technology to detect and warn of man-overboard situations on platforms and vessels. Such changes would require clear, statistical and quantitative evidence of the costs and benefits of different methods, and any additional procedural changes which could preserve life. Analysis of this problem using the Trident sequence and the eight process GEMA framework could identify aspects of the preparedness, response and learning from 'man-overboard' incidents that could be addressed by using simple and efficient means. Helicopters are a costly option and are inefficient in a number of different offshore scenarios. Addressing the problem through preparedness and learning is clearly more desirable, and the process-oriented approach could assist in this.

The management of emergencies in tunnels was a second research issue that was explored. Examples across Europe show that although the technology to construct and operate tunnels has advanced continually over the past century, there has been less attention paid to developing evacuation and safety systems.

"...it seems we build a lot underground, but few countries have general rules for fire and life safety principals"

(International Tunnelling Association, 1998: 217)

Over the past 24 years a number of accidents have drawn attention to the vulnerability of people travelling underground, whether in trains or cars. The recent increase in awareness of terrorism following September 11th 2001 has amplified public concern about their safety when underground, with particular reference to the Tokyo incident involving Sarin gas.

Figure 9-2 History of underground tunnel emergencies

Date	Location	Incident type	Consequences
1979	Nihorzaka, Japan (Carvel, Beard & Jowitt 1999)	Fire in road tunnel	7 Dead 189 vehicles destroyed
1987	King's Cross, London (Fennel, 1988)	Fire in underground station	31 dead 100 injured
1995	Baku, Azerbaijan (Atwell & Khanlou, 1995)	Fire in underground tunnel	300 Dead 260 injured
1995	Tokyo, Japan (PolICASTRO & Gordon, 2001)	Terrorist release of Sarin gas on underground trains	12 Dead 5500 injured
1999	Mt. Blanc (Duffé, 1999)	HGV fire in road tunnel	39 Dead 38 vehicles destroyed
2000	Kaprun, Austria (Anonymous, 2001)	Fire in ski train tunnel	155 dead
2001	St. Gothard Tunnel, Switzerland (The Times, 2003)	Fire following collision in road tunnel	11 dead

Cranfield continues to work with partners to establish advanced safety systems and emergency protocols for underground transport systems. The possibility of applying GEMA to various underground EM systems in the UK is currently being discussed. It is not thought that the model would require a large amount of adjustment to be used in the assessment of capability and maturity of an underground emergency management system, as the principals of risk-based planning and improvement focussed response still apply strongly.

9.3.4 Further work in Risk and Disaster Management.

The narrow void between industrial and natural hazards is illustrated simply by Lillibridge, in Noji (1997: 360). He discusses the case of Lake Nyos in Cameroon, Africa. Nyos is a volcanic crater-like depression in active field, which has formed a lake. In 1986 a massive release of from under the lake at night is thought to have asphyxiated 1700 people as they slept.

Although an industrial site with such quantities of CO² is likely to be more closely monitored and have safeguards in place, there are lessons which practitioners on both sides of disaster management can learn from sharing analysis of such incidents. It is likely that the literature would reveal a number of natural disasters and man made emergencies that share many common elements. The 1983 disaster at Bhopal in India bears a close resemblance in its immediate effects to the cyclone on the Gujarat coast in 1998. In both cases a vulnerable population was living in a location where a known hazard existed, and political factors influenced the effectiveness of the warning system, resulting in thousands of people being unable to escape in time from a deadly force. Clearly, vulnerable impoverished populations are more likely to suffer the effects of any disaster, however comparison between the organisational and political factors involved in both natural and industrial disasters could reveal interesting lessons for both disciplines.

Focus on processes rather than products of a response opens a new perspective and prospect for the comparison and learning across sectors are

regions in emergency management. There is no structural reason why the eight processes identified in the GEMA framework could not be used in an assessment of national response strategy, or a system designed for response to a large-scale natural disaster.

Events over recent years in the UK agricultural industry have illustrated that a disaster does not have to have human victims for the suffering and damage to be felt by the nation. The foot and mouth disease crisis showed inadequacies in the response systems that were a direct result of failure to learn the lessons of the last outbreak. Risk, emergency planning and emergency response are not common terminology in the agricultural sector, however the frameworks developed for dealing with epidemics and emergencies in the human population are likely to be as effective when applied to agricultural systems. The principals of a risk-based, continuously improving maturity approach might easily be applied to farming systems. This would require a significant research commitment from the appropriate body; however the potential applications and benefits are encouraging.

9.4 Concluding remarks

Successful emergency management, which is often attributed to luck and good training, has been distilled into eight measurable processes, which operate across three phases of development and provide an indication of an organisation's position on a scale of five levels of capability and maturity.

It has been a privilege to carry out research in a field where the results can be applied directly to improving an important aspect of industrial activity. Although the GEMA framework is not yet thoroughly tested in MAHI, it provides the basis for a more accountable and broad-based assessment of capability and maturity in EM, which if implemented will enable organisations to establish and continuously improve their emergency management systems.

A continually improving emergency management system enables organisations to more effectively and efficiently achieve the ultimate aim of every person working in the field of disaster and emergency management - to protect the environment and assets from damage and to save life.

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Appendices to the thesis

To aid the continuity and clarity of the numbering, the Appendices will be labelled as Chapter 10.

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10.1 Exercise analysis data

The following section presents the full analysis of data collected at the emergency exercises, concluded in Chapter 5. Each organisation visited has been assigned a two-letter code to identify their data throughout the thesis.

For each site a paragraph of background information is given to set the scenario for the exercise. A table then gives the background information to the site. This will be followed by a summary of the processes that have been proven in the exercise. These processes should be similar to those identified in the PCMM, detailed in Chapter 3. Any novel emergent processes will be discussed at the end of the chapter. This structure will be repeated for all 8 exercises used in this study.

10.1.1 Analysis of emergency exercise DA

The following paragraph describes the scenario of the exercise at DA.

The scenario involved an explosion in a plant which dealt with radioactive materials. Fire and radiation alarms sounded, and the muster indicates a number of missing members of staff in the incident building. The team are expected to carry out the necessary monitoring, determine the nature of the incident and rescue the casualties. Risk to the casualties, rescuers and the rest of the site should have been considered throughout. Cooperation with the external emergency services was required to rescue the casualties. The scenario was realistic, detailed and well planned. The EMT appeared to work very efficiently and effectively but the rescue of the casualties by the fire brigade was late and uncoordinated. The exercise ended after two hours twenty minutes.

Figure 10-1 Background information on site DA

Brief site introduction		
DA is a Nuclear Licensed Site in a rural location. The main hazard is radiation; however there are also explosion, fire and pollution hazards. The site has a large population of employees and contractors. DA is regulated as a COMAH site and also as a Nuclear Licensed Site. Most likely scenarios are contained within a building or a plant, and pose little offsite risk. There are some potentially large scenarios, but the overall offsite risk is lower than many MAH sites. There are no domino sites (other hazardous industry close by, which could be affected.)		
Equipment and Facilities	Organisation	Training
<ul style="list-style-type: none">• Site and building alarms, established and well-drilled system for fire and radiation• Telephone based muster system• Purpose-built Emergency Command Centre designed to survive a major incident• Very basic back-up ECC• Medical staff with ambulance and decontamination facilities, however some capabilities rely on assistance from nearby site, and response from external services would not be possible in time.• Site fire and rescue capability is risk-based and externally assessed.• Communications equipment is secure and back-ups are available• ECC is equipped with display equipment, clocks and IT support	<ul style="list-style-type: none">• The emergency management system is based on risk, and is taken seriously• Level of site respect for and confidence in the off-site fire service is poor, as they have little understanding of the specific risks.• Corporate weakness in building effective relationships with external emergency services• Rota-based EMT, respond instantly during day, and within 30 minutes out-of-hours• Cascade telephone system to call in back-up skills if any team member is missing.• Simulations are of a very high standard – detailed, realistic and thorough. Mostly for demonstration of competence for Nuclear regulator rather than COMAH ‘plan testing’ remit.	<ul style="list-style-type: none">• Good range of appropriate procedure for muster and evacuation, well understood at all levels and practiced regularly• Response demands are well assessed, resourced and defined• Performance across the site is not uniform. Plant and building capabilities vary, although EMT is consistently capable.• Ownership and confident use of information management system.• Checklists available to on-scene controller• High level of selection and training for emergency managers (EMs)• Actively seek examples of best-practice elsewhere.• Refresher training system is infrequent, not well resourced and relies partly on practice in real incidents• Competency assessment is carried out for EMT, but not facilities staff. Externally calibrated, probably best in field.• Continuous selection, training and competency assessment system.

Figure 10-2 CMM Processes observed at DA

Communication & coordination	The communication within the ECC was of a high standard, facilitated by highly trained individuals and well designed equipment and procedures. The EM also communicated well with the rest of the site, illustrated by regular PA announcements and a timely and comprehensive muster system. The communications between the ECC and the external emergency services was deficient however, and this was the reason for the delayed casualty rescue.
Work environment	This process was defined as the establishment and maintenance of physical working conditions to enable personnel to perform tasks efficiently and without distraction. The ECC was custom designed and provided a high standard of facilities, safety and equipment. The layout of the room facilitated efficient information management and communication between the EM, EMT and the site. The lack of information from the site along with the inflexibility of the local fire brigade resulted in a long delay to the rescues.
Training and development	The training described in Fig. 40 is clearly effective, as this response team is able to demonstrate their capability in a challenging and realistic scenario. The ECC was operational within a very short time span, and nearly all members of the EMT were able to carry out their responsibilities without requiring further instructions. The logger responsible for writing up the actions was new to the position and untrained, resulting in the board being poorly used. From the success of the simulated muster, the site population also seems to be well drilled. Further training with the external emergency services would be a recommendation of this exercise however.
Staffing	The level of trained emergency management staff at this site is very high for an organisation of this size. The number of staff in the EMT and the response system as a whole is appropriate to the level of hazard, and based on incident experience. The EM and DEM are selected and trained specifically for their roles, and are put through rigorous competence-based training and simulations. The other staff involved in the EMT and ECC response appear to be a committed and dedicated group, with capabilities commensurate with the level of hazard.
Workforce planning	This process is the alignment of the workforce abilities with the current and future needs of the organisation. As the site population is reduced considerably during the night, a lower level of emergency response is provided for this period of lower risk. In this context the needs of the organisation are the hazards and the risks they pose, which are well understood and planned for on this site.
Organisational capability management	The details of the EMT rota and on-call staff for emergency response were gained in the pre-exercise briefing. The site has a large number of people who are trained in emergency roles. This enables them to have back-up team members if someone is missing.
Quantitative performance management	This process concerns the setting, testing and maintaining of quantitative targets for performance. During the pre-exercise briefing, details were given of quantitative targets for call-out, muster, attendance at the scene and rescue. In the exercise itself, action points were given an estimated time of completion and the actual time of completion was recorded. This is an important higher-level process which forms the basis of continuous improvement.

10.1.2 Analysis of exercise MA

The exercise was an extrapolation of a near-miss event which had occurred, and as such was a realistic risk-based test of the response. The information feeds to the ECC were prompt and very straightforward however, and the EM and EMT were not noticeably pushed beyond their comfortable range of experience in managing this incident.

The scenario began with a reported fire in a storage area containing flammable and toxic chemicals. The weather conditions were dry and clear, with a strong wind blowing across the site. The ECC was staffed within seven minutes of the pagers being activated. Within a minute of arriving at the ECC, the Environmental technician on the team had ensured that the drainage system had been switched to contain all contaminated fire-water. Within 13 minutes of the exercise, the team are informed that the fire has been extinguished, but the plume has now activated the gas alarm. Sixteen minutes into the exercise, the external fire brigade arrive at the site and are given a very effective and succinct briefing. They are directed to a holding area until the nature of the plume is identified. Simulated calls from the public and press made to the ECC were handled well and the exercise ended after 50 minutes.

Figure 10-3 Background information on site MA

Brief site introduction		
MA is a large chemical site at a coastal location in the UK. It is in a rural environment, but there are other 'domino' industrial sites nearby, and some residential areas nearby. The main hazard is leakage of toxic chemicals. Certain chemical leak scenarios would cause injury to persons within a 5KM radius of the site. Common incidents involve leaks of toxic vapour, and spillages into bunded areas. Worst case leaks would be failure of a 30 tonne storage tank, or damage to hook-up valves resulting in leakage from a road tanker. The site has a large day population including contractors, and a skeleton night population.		
Equipment and Facilities	Organisation	Training
<ul style="list-style-type: none">• The site has scrubber units, which can neutralise leaking gas• Buildings have two speed extractor fans, to ensure constant ventilation and have capacity to 'purge' building if necessary• Multitude of alarms and computer monitoring, which can be difficult to interpret.• There are 12 gas-tight shelters and 48 other designated shelters on the site.• Site has effluent treatment plant and contaminant storage lagoon with controlled site drainage.• Communications are tested weekly, with 100% success.• ECC is equipped to good standard, but there is no back-up ECC.• Phones and power supply have back-up options.• Mobile gas detection vehicle.• Casualty decontamination facilities at OH centre	<ul style="list-style-type: none">• The same EMT deal with all scenarios on the site.• Procedure for site is to shelter for a gas leak and evacuate for a fire.• Several scenarios exist where the sheltering population would not be totally safe from the gas leak, and unable to evacuate.• Target of all staff to be under shelter conditions within 2 minutes of the alarm sounding.• Common cause of problem is people misusing the electronic entry tagging when entering or leaving an area. This system helps compile the roll-call data in an emergency.• Site fire team has 2 minute response target to anywhere on site, and can be in breathing Apparatus within 3 minutes.• Water curtain can be set up anywhere on site within 7 minutes of arrival.	<ul style="list-style-type: none">• Gas emergency plan is practiced twice yearly; building evacuation plan is practiced yearly for all staff.• EMT are trained to a high level.• Fire team are trained to very high professional standard with the local brigade, each local shift trains on site at least twice yearly.• Learning from exercises is good, and has shown that the systems are good and consistent; however the people sometimes are less than adequate.• Shift staff is trained to wear BA to carry out remedial engineering on plant.• Major casualty incident plan invoked for more than two injured persons, medical staff are well trained in chemical exposure and burns response.• EM is selected and has a 6 month training course in BA, fire, and theory

Figure 10-4 CMM processes observed at MA

Communications & coordination	<p>The availability of communications methods was adequate for a site of this size; however aspects of the communications technology could be improved. The process of communication involves a person transmitting the message, the medium by which that message travels and a person receiving the message. The objective is for the message to be transmitted in tact. It is also important for the medium to be secure. Headsets for the radios and clearer system for answering and dealing with telephone calls would improve the communications process. This is a key foundation process in emergency management, because many aspects of the response depend on it.</p>
Work environment	<p>The process of selecting equipment and facilities appropriate to the likely hazards is an important foundation to successful emergency management. The technical fire-fighting capability of this site is high, with an impressive livery of modern equipment. The occupational health centre and associated equipment and capability is also of a high standard. A media briefing room is newly completed and an emergency services liaison room has just been built. The ECC however is quite small and crowded, and would be uncomfortable to work in for any length of time. The equipment within the ECC is adequate, but there is no back-up ECC.</p>
Training and development	<p>The training process for this site includes integrated training with the local fire brigade (LFB). The level of operational training appears to be comprehensive, with staff being trained in fire, chemical and first aid procedures. Each member of the EMT is trained with a primary and secondary role, to ensure that the full team can always be achieved. Individual buildings have an incident officer (IO), responsible for muster. The IOs are trained by the EMT, ensuring that the training is specific and appropriate. EM undergoes a 6 month training course, which is operationally focussed, with little emergency management training. EMs also participate in training that is specific to certain chemicals stored on the site.</p>
Staffing	<p>Ensuring that there are adequate members of staff in place to carry out the response is an important process, and as this site demonstrates, it should be a risk-based process. Because there is lower activity on the site during the hours of darkness, fewer staff are needed to respond to an incident. The number of staff available at the incident FCP and ECC have been calculated to deal with any reasonable occurrence. Due to staffing structure, a small number of individuals are on call 365 days a year. This issue is under review, as is the recommendation that a DEM be appointed.</p>
Competency development	<p>The site has recently adopted a 'competency matrix' approach to emergency management training and exercising, where each EMT member has the opportunity to practice and enhance a range of competencies throughout the year. Experienced members of the EMT are also used to train new members of staff in EM, on an informal basis.</p>
Quantitative performance management	<p>The process of defining, measuring and assessing quantitative targets for performance is the basis of continual improvement, and is important in the rapidly changing environment of emergency management. This site has time targets for a call-out of the EMT, fire attendance at an incident and fire response in terms of crew in breathing apparatus (BA) with water and foam equipment operating. They also have a target of 20 minutes for gaining control of the incident. It was not ascertained how often the adequacy of these targets is reviewed, but it was indicated that records from each incident and exercise are reviewed to check the achievement of targets.</p>

10.1.3 Analysis of exercise RA

The scenario began with a release of a toxic gas on the site. This release was detected by the alarm system. The exercise was an out-of-hours test, primarily to test how long it would take to call-out the full EMT. The alarm sounded and the call-out was made at four minutes past midnight. The fire Team Leader arrives at the scene within 7 minutes of the alarm sounding. He initiates gas monitoring around the access points to the building. There is was a heavy load of information fed into the ECC.

Figure 10-5 Background details of site RA

Brief site introduction		
<p>RA is a Nuclear Licensed Site in a semi-rural location. The main hazard is a large toxic gas release. There is a large inventory of one particular hazardous chemical, but the likelihood of a major incident involving this chemical is quite low. During the day there are over 500 staff plus one hundred contractors, and there are fewer than 50 staff during the night. There is little threat to the offsite population.</p>		
Equipment and Facilities	Organisation	Training
<ul style="list-style-type: none"> Modern alarm system, PA and dedicated muster phone system. Site fire brigade and ambulance are well equipped ECC has print-off information boards to print a record of the events. Single channel emergency radio system, with no security features. ECC well equipped making full use of latest technology No back-up ECC, however incident range suggests little chance of losing ECC 	<ul style="list-style-type: none"> Aim to muster and account for all personnel within one hour of alarm Two levels of EMT response – one room of communications, muster and liaison which can always be staffed from the onsite personnel. Second room of emergency managers which can be staffed within one hour of the call-out. Flaws in call-out system as low response to beepers, due to lack of commitment ECC can be set up swiftly and smoothly by experienced team Mandates between the emergency managers in the front room and the EMT in the back room are sometimes confused. Muster system is well understood, rapid and accurate Site management is very committed to emergency management system. 	<ul style="list-style-type: none"> All staff are trained how to respond to different alarms All staff are trained in basic fire procedures Communications operator in ECC is a plant manager normally, and so understands the technical details Deputies and back-up teams are not trained to as higher standards as EMs Although competency is mentioned as an outcome of training, there is no formal definition of competency No refresher training scheme is provided One full exercise per year, limited training opportunity outside this Risk-based first aid capability – good practice Site fire brigade train with LFB and have good relationship. Fire training is in line with latest technology and innovative practice EMT members trained for primary and secondary roles as back-up for missing colleagues Shift managers are developing training modules.

Figure 10-6 CMM processes observed at RA

Communications& coordination	This exercise highlights the fact that even if a communication method if clear and timely, effective response is dependent on the recipient taking the required action. Although the ECC call-out method was timely, the response is disrupted by EMT members failing to respond correctly because of lack of commitment to the procedure. The delay before briefing the LFB indicated a lack of forward planning, and the lack of radio headsets made communications methods less effective.
Work environment	It is clear that the process of creating a safe and efficient work environment had been considered at this site, and considerable investment in new technology had been made. Fire and medical facilities on site were adequate for the risk faced, however there was a lack of chairs and refreshment facilities in the ECC which would put physical pressure on staff during a protracted incident.
Training and development	Emergency management training and development is carried out, and an improved system is being implemented. Modules are being written by experienced EMs, and these will be used to train all EMT staff. Frequency of updates and training opportunities is still quite low, with only one exercise per year. As a process, training and development does not seem to have been dealt with in its entirety, rather it has been put together from smaller, somewhat ill-fitting components.
Staffing	The site ensures that each role has a back-up member of staff who is trained to carry it out if the key member is missing. This system is considered good practice, as it ensures the integrity of the team in all circumstances. There is no selection procedure for the EM, it is based on seniority in the organisation. The level of staffing has been considered in relation to the risks posed, and the structure of the team is capable of managing the threats on this site.
Workforce planning	The process of planning the emergency management workforce has taken place at a basic level, with the separation of the strategic management and operational parts of the ECC. It has been recognised that early in an incident the response is mostly operational and procedure based, and so the staffing of the front room is a more urgent requirement than the back room.
Competency analysis	The process of analysing emergency tasks to determine the competencies required has been carried out in this organisation, and a training programme made up of competency based modules is being formulated. The competencies identified include information management, dealing with the media and command and control.
Workgroup development	Development of an intra-dependent emergency management team is being carried out in this organisation. EMT members are trained to carry out a primary and secondary role, to ensure that the full expertise of the EMT is available even if members are missing or delayed.

10.1.4 Analysis of exercise HA

The scenario involves the leakage of a flammable gas which is stored in liquid form. This leak finds ignition a pool fire starts underneath one of the large tanks of this gas. The fire soon escalated and produced large amounts of dense smoke. The initial muster results at 11 minutes reveal that two men are missing. At 13 minutes, the gas cloud was above the acceptable concentration and drifting beyond the perimeter. The offsite warning was sounded. After 21 minutes the FCP reported to the ECC that there were a total of five people missing from the incident area, comprising three contractors and two site personnel. The pool fire was extinguished after 30 minutes, and engineers were unable to access the leak until the area was cool and tank pressure had receded. Despite strong pressure from the police to re-open a nearby public road, the EM refused to declare the area safe until the leak has been sealed. The exercise ended on that stalemate.

Figure 10-7 Background details of site HA

Brief site introduction			
HA is a hazardous chemicals installation at an urban location. It has a large site population, and is surrounded by other industry and residential areas. There are over 2000 people onsite during the day and just over 100 during the night. The main hazards are toxic liquids and gasses and highly flammable and explosive substances. There is a high potential for rapid escalation incidents, and off-site consequences are probable in any major incident. The site has many incidents each year, and the emergency management system is regularly used to deal with a range of scenarios.			
Equipment and Facilities	Organisation	Training	
<ul style="list-style-type: none">• Comprehensive and regularly tested alarm system, incorporating emergency telephone network• Fire-fighting equipment is latest technology for dealing with the full range of incidents that could occur on site.• On-call EM has blue-light on his car to drive to the site.• ECC is always manned by a communications officer who monitors alarm panels.• ECC well equipped with some custom equipment.• Back-up ECC is available as a skeleton facility with maps and crash-packs• ECC perhaps only lacking in forward-thinking aids• Adequate communications, secure and backed-up.	<ul style="list-style-type: none">• Muster target of five minutes on individual plants• Risk-based standards of fire cover, considering gas cloud and fire scenarios.• Senior management highly committed to emergency management• FCP has control of incident management, and EM controls the offsite and wider liaison• Low turnover of EMT• Mentoring of new EMT members is being considered by site• Pager response of EMT within 3 minutes is standard. Assistant EM arrives within 10 minutes and on-call EM within 30 mins from offsite.• Succinct and well established written procedures.• Assistant EM, but no DEM. DEM is useful to replace EM if missing.• Problem of an aging population of EMs• Emergency management is taken seriously but not always treated systematically.	<ul style="list-style-type: none">• Expert relationship and integrated training with local emergency services.• Comprehensive and well rehearsed muster system, widely understood.• EM is required to have 20 years plant experience and complete a 12 month training course, however no test in a realistic simulation.• Risk based consideration of likely injury from incidents, and ambulance training is based on dealing with these.• High standards of selection for EMT members and fire team members. Latter need superior fitness and team working skills.• Comms officer trained to high standards and does the job full time.• Comprehensive scenario training based on real incidents.• Refresher training is implemented, and competence is judged by in-house expert, but no records kept• Exercises are designed for maximum training benefit.	

Figure 10-8 CMM processes observed at HA

Communications & coordination	The communications process demonstrated on this site was effective and efficient. The exercise showed a well practiced team using equipment and procedures that had been honed to meet the needs of the organisation. Despite some contractor errors in the use of the muster identification system, the communications process went well.
Work environment	The process of selecting and equipping the environment in which to conduct the emergency response had been carefully developed through practical experience and expert consultation. The fire-fighting and medical capabilities on this site were sufficient to cope with a range of incidents until the arrival of the local emergency services, and the ECC facilities enabled swift and efficient organisational response, with adequate back-up available.
Training and development	Emergency management training and development are treated seriously in this organisation; however the current level of capability will not be sustainable unless replacement EM and DEM candidates can be trained. This may require changing their requirement for 20 years plant experience and opting for EM mentoring and competency based development. Fire and medical staff are trained to the highest peer standards, and integrated training with the local emergency services is regularly carried out.
Staffing	The EMT in this case was very lean, but worked well. The Assistant EM was not qualified to EM standard, and so could not replace EM if needed. If the three members of the EMT were any less capable, the team would be fragile. The division of responsibility between the FCP and ECC is well defined and perfected through experience, the overall capability being based on the risks.
Workforce planning	All the EMs on the rota have to live within 30 minutes drive of the site, and the required response times are adjusted according to the level of site occupation during the day and at night. Response from EMT members on-site shows the high level of commitment from all areas of the organisation.
Quantitative performance management	The organisation realises the importance of quantitative target setting and has strict emergency response standards across the site. From the observed feedback session, it appears that the targets are used as indicators of performance problems and as a basis for action.

10.1.5 Analysis of exercise HB

The exercise HB was carried out over a year later at the same site as HA, so the background details of the site (fig. 48) remain very similar. The ECC has since been refurbished, and had been fitted with new lighting and a GIS computer system which contains photographs of all areas of the plant. These pictures could be projected onto a large screen or printed and annotated for the emergency services or FCP use. Each EMT member also has a checklist for their role. This exercise could be a useful indicator of how a site capability changes over a period of time, an issue which will be discussed in Chapter 9.

This exercise is based on a real incident that resulted in offsite consequences. It involved a liquid flammable leak from storage tank pipework located before the emergency shut-off valve, so it could not easily be controlled. Personnel investigating the incident are trapped nearby and injured when the leak ignites and causes a jet-fire impinging directly onto the tank. The deluge system has recently undergone repairs, but the nozzles are clogged with corrosion product and not functioning effectively. The jet fire is 45m long, and leakage into the containment pit around the tank also catches fire, burning to a height of 4.5m.

The exercise was preceded by a video showing footage of large fires on chemical plants, the intensity with which they burn and the damage caused. The impact of this was good, as it provided a mental picture of the likely consequences of the incident. Twelve minutes into the incident, the FCP confirm that the two engineers attempting to isolate the leak before it ignited are now missing.

The LFB are stood down after one hour 30 minutes, when the relief valves close and the risk of BLEVE dropped. The EM instructs FCP to carry out environmental impact estimate and assess any remaining fires. The exercise ended after 1 hour 45 minutes.

Figure 10-9 CMM processes observed at HB

Communications& coordination	There were many aspects of this exercise that indicated the importance of the communication process in emergency management. The exercise highlighted the need for pre-planned communications with the LFB, which would enhance the speed and effectiveness of the response. The exercise also showed the need for reliable, frequently tested communications technology.
Work environment	The ECC had been recently refurbished, providing a better quality of lighting as well as GIS capability and further information display tools. The FCP was carefully managed and steps were taken throughout the exercise to ensure the safety and security of the staff involved in the FCP, and keep them updated on the situation.
Training and development	The inclusion of a DEM of equal status to the EM has indicated a higher commitment to training at the site. There has also been a planned approach to exercise-based training with a range of different scale exercises taking place throughout the year.
Staffing	The staffing process has been considered at this site, and refined since the last exercise. The Assistant EM post has been replaced with a DEM of equal status to the EM. A logger has also been added to the ECC, allowing the comms officer time to concentrate on information management. This four-man team was much more stable than the previous arrangement of just three.
Workgroup development	The FCP and ECC have developed well on this site, becoming inwardly stronger and more efficient. The workgroup development process is the strengthening of workgroups, reduction of inter-group dependency and ensuring that when a workgroup's task is complete, they disband in an ordered process which preserves its assets, records the task and outcome. The formalised exercise review ensures that knowledge and learning are preserved from any incident or exercise.
Performance management	The use of a formalised exercise analysis process on this site is indication that the organisation is attempting to establish objectives related to their emergency response. The aim will be to measure individual and team performance against these objectives. The performance evaluation will then be used as feedback for process improvement.
Competency analysis	The training process for EM and EMT members involves a lengthy course of study to develop different skills and competencies. As a basis for this training, there has been some analysis of the different emergency management tasks to determine the competencies necessary to carry them out. This has been carried out to a large extent on this site, but is yet to be formally defined in a competency analysis document.

10.1.6 Analysis of exercise ZA

The scenario was challenging for the team, because was different to the chemical leak and fire exercises they usually used in training. The scenario simulated the catastrophic failure of one of the electrical transformers which supplied the site and some of the surrounding area with power. The transformer was located in an area of the site containing mainly occupied temporary 'Porta-cabin' type buildings, one of which had been set alight and the entrance blocked by debris during the explosion. Due to the loss of all power, the vast office population of the site had made a decision to leave work early, as the power was off. Failure to take action to control the site population exasperated the scenario and traffic attempting to leave the site on this road had skidded on the oil causing a RTA which blocked the road and prevented the ambulance from getting through. By 44 minutes the Porta-cabin is engulfed in flames, and rescue is not yet possible due to poor communication between the EMT and site fire service. The rescue of the people trapped in the portacabin was not possible until one hour and five minutes after they had become trapped. The exercise ended after one hour and forty minutes

Figure 10-10 Background details of site ZA

Brief site introduction		
ZA is a pharmaceuticals site with a large site population. The site has recently expanded and the emergency management system has not yet adapted to manage this change. The EMT is drawn from the senior management team and is newly established. Auxiliary roles such as logger and communications operators had not been trained at the time of the exercise. The main risk is a large fire involving toxic chemicals. There is also risk of toxic gas leak, bio-hazardous material leak and leak of environmental contaminants. There is low risk of a domino incident or hazard to the offsite population.		
Equipment and Facilities	Organisation	Training
<ul style="list-style-type: none">• Basic level site fire service with one tender. Capabilities are defined from a fire risk assessment• Site ambulance and health centre, with ample capabilities. 24hour nurse and paramedic capabilities.• ECC has basic facilities, but is not in dedicated accommodation.• Current alarm system is insufficient and often inoperable• Communications technology is insecure• Equipment and capability is due to be upgraded, giving more comprehensive support to new emergency management system.	<ul style="list-style-type: none">• Only one full EMT is available. Others not yet trained• Full EMT is not available in silent hours• Current muster and evacuation system in inoperable• Silent hours call-out is ad-hoc and insufficient• There are no documented emergency management procedures• No back-up measures for missing members of EMT• There is some senior management commitment to developing the system, but this is not carried through into operational support• The scenario was quite realistic and challenged the team.• Little or no demonstration of learning from the exercise, or capability for feedback and learning.	<ul style="list-style-type: none">• Site personnel are not trained in muster procedures• Site fire service are well trained to professional standards• There are no selection standards for EM, DEM or EMT members• There are no defined competencies for EM, DEM or EMT• There is no refresher training programme for any of the EMT or EM and DEM• Exercising and training are carried out in an ad-hoc manner, and there is no overall plan or structure to training and development• Site developing emergency management capability from scratch, so not yet fully capable.

Figure 10-11 CMM processes observed at ZA

Communications	The exercise illustrated that this process was being carried out at a low level. Communication between the site and the EMT had been poorly planned, and was due for updating. Communication failure allowed office staff in the scenario to try to leave the site, causing congestion, a traffic collision and a delay in attending to casualties.
Work environment	The process of assessing the needs and providing a safe and efficient environment in which to work had been considered and has started to be implemented on this site, however it has not yet reached a fully operational state. The ECC is normally configured as a meeting room, and is slow to set up. There are no dedicated outside telephone lines in the ECC and no back-up power supply or back-up ECC.
Training and development	The process of training and development is very much in progress at this site, as the recent changes to the workforce have resulted in a new team structure and make-up. The full EMT has not yet finished the training programme, and the schedule of exercises is not yet established.
Staffing	The process of assessing the risk and determining the staffing levels to manage a site emergency is still underway on the newly restructured site. A core team is in place and undergoing further training, however there is no rota of team members, and currently the core team is only available during office hours. Further selection and training of EMT staff needs to be urgently undertaken to ensure a 24hour, year-round availability of the EMT.

10.1.7 Analysis of exercise WA

The scenario began with a loss of power across the site. Within three minutes the EM and DEM had arrived at the ECC, and the UPS had engaged. After nine minutes the EM called a time-out and informed the team that the alarms were indicating a radioactive release, and their immediate priority was to determine the location, scale and cause of the release in order to stem it. At the end of the T/O the site alarms were sounded, and a report was received of an explosion in a building housing a radioactive coolant pipe. There will also be a requirement to move the ECC, as the UPS will only last for 2 hours. Attention should also be given to the matter of controlling the release. There was also a request to evacuate 102 contractors who were suffering because of the heat and lack of air circulation in the building where they had sheltered. The exercise ended after 2 hours forty-five minutes, following confirmation that the leak was sealed and air quality was returned to normal.

Figure 10-12 Background details of site WA

Brief site introduction		
<p>WA is a Nuclear Licensed site with a large site population during the day, and small skeleton population at night. The site houses a diverse range of high technology plant, incorporating complex automatic shut-down systems. This can make incident diagnosis very difficult. The major risks are of radiation release, toxic gas leak and fire or explosion. These pose a significant offsite risk to the surrounding rural and semi-rural population. The site has a strong background of emergency management exercising and actual response.</p>		
Equipment and Facilities	Organisation	Training
<ul style="list-style-type: none">Manual role-call system is laborious and aged.The ECC is well equipped and in a high state of readiness, and under continual refinement.A back-up ECC is available and is well equipped.Risk based fire and rescue capabilities with modern appropriate equipment.Comprehensive radio communications, but not totally secure.Separate radio system for emergency services.Well honed facilities for information management.Capable and experienced media team	<ul style="list-style-type: none">The site has a target of 90 minutes for a complete role-call, conducted manually.The site has a strong emergency management culture which results in high commitment to training by senior management.Call-out procedures are prompt, reliable and effective.There is a large bank of trained EM staff from which a number of teams can be drawn. There is also sufficient staff to set up satellite support teams at other locations.Mandates are clear and well understood.Capable and committed senior management.High standard of learning lessons from exercise through feedback and debriefing.	<ul style="list-style-type: none">The training of the EMT is risk based.Training programme is well resourced, in terms of people and the quality of the output.Fire Brigade training in line with national professional standards.Teams are cohesive and train and respond together, building capability.Training is knowledge based, but not totally recorded however.Competencies are not formally defined or recorded but understood and valued.Refresher training scheme in placeSelection and training for EM are difficult to separate, as selection continues through training scenarios, and can be de-selected throughout the training programme.

Figure 10-13 CMM processes observed at WA

Staffing	The organisation has shown evidence that the staffing of the EMT has been carried out as a process based on the requirements of managing site emergencies, and ensuring the safety security of the personnel. A pool of trained staff has been created, from which an appropriate response can be drawn at any time.
Communication & coordination	The hardware is in place to ensure efficient and effective communication across the whole site. The teams are well practiced in using the equipment, which has been configured especially for the demands of this site. Verbal and interpersonal communications are managed well in the ECC, using a range of technological solutions, staff acting as facilitators and efficient display of information.
Work environment	The process of creating an environment in which tasks can be completed in a safe, efficient and secure manner has clearly been considered at this site. ECC facilities and back-up facilities have been allocated and equipped with due consideration to the risks and likely conditions in which the facilities will be used.
Training and development	A thorough process of selection, training and refresher training takes place on this site and exercising is used for training staff and demonstrating capability to the regulator. Teams train and practice together, therefore strengthening their roles and intra-dependence.
Workgroup development	The process of increasing team cohesion and reducing dependence between teams has been proven on this site. The process aim is to develop intra dependency within task groups and minimise interdependency with other task groups. When a workgroup's task is complete, they disband in an ordered process which preserves its assets, records the task and outcome. This process is strengthened by aiming to keep teams together throughout training, and on the call-out rota.
Performance management	Performance of the EMT and response during an incident or an exercise is logged, analysed and the lessons learned are used to make changes to the procedures. Further exercise opportunities are then designed to test the changes. This process is clearly established and valued by the organisation.
Competency analysis	The emergency management tasks have been analysed to determine the knowledge and skills required to carry out those tasks. Although this has not been recorded formally within the written training procedures, competency-based training is conducted and appreciated as being useful.
Workforce planning	This process plans the availability and structure of the workforce according to current and future needs. On this site the process involves maintaining a group of trained emergency management staff large enough to provide a full response at any time. In addition to this, there is sufficient duplication of roles to enable satellite support groups to form at a separate location to support the EMT on site.
Quantitative performance management	The process of setting quantitative targets for tasks has been undertaken on this site, and training and exercising monitors the achievement or failure to achieve these targets. If targets are consistently missed, then adjustments to working practices, facilities and equipment or plans and procedures are implemented and tested.

10.1.8 Analysis of exercise GA

The scenario began with a leak reported in the loading area. Within 9 minutes a loud explosion was heard and the EMT were informed that the leak had ignited and a 60m vertical jet fire from one of the vehicles containing a refrigerated flammable gas. Media response and business response teams were activated and the current site inventory was checked to ensure that production could continue without need for the now disrupted delivery. Two casualties are awaiting rescue near the vehicle. The exercise ended after one hour and five minutes, when the fire was brought under control.

Figure 10-14 Background details of site GA

Brief site introduction		
GA is a large chemical site, in a semi-rural location but close to other hazardous sites. The worst case incident would be a toxic gas leak or flammable gas leak and fire. Some of the auto-shutdown technology on the site is dependent on the electricity supply, so any problem involving a power cut and flammables incident would require rapid intervention and quick thinking. The site is thinly populated and the muster system is designed to meet the needs of that site. The inventory is well dispersed around the site, and so internal multi-plant incidents are unlikely; however some incidents are of high enough magnitude to have a domino effect on other nearby sites. The emergency management system has been tested in real incidents on numerous occasions and has proved to be steadfast and reliable.		
Equipment and Facilities	Organisation	Training
<ul style="list-style-type: none">• The muster system is based on gathering outside, and no shelter option is available, as any leak would be well dispersed outside.• Alerting system comprises site siren, zone sirens, 'muster active' lights, site mobile phones and radios.• Site ambulance, well equipped technicians and good relations with local ambulance service• Fire fighting capacity is world-class. High capacity foam and water tenders can respond anywhere on site within 5 minutes. Use latest technology.• Extensive site maps and GIS with CCTV and photographs accessible by computer.• Hands-free telephones and radios• Copier-white boards for record keeping.• Very well resourced ECC.	<ul style="list-style-type: none">• Whole site muster in 60 minutes- frequently achieved, high standard• Site organised in several zones to allow area specific warnings and musters.• ECC manned within 15 minutes by shift manager, within 45 minutes by duty EIM (day or night). Risk based decision.• Strict staff selection and health monitoring increases safety, reduces staff medical problems on site and illness off site.• Culture of readiness and willingness to respond• Strong senior management commitment through safety policy and through resources and support.• Site area safety groups meet regularly to hear employees concerns and solve problems.• Mechanism to record and learn lessons from exercises	<ul style="list-style-type: none">• Fire fighters train with local emergency services, and have longstanding relationship.• Trained to respond rapidly to quell any incident before escalation.• Risk-based structure and composition of team, willingness to be flexible in duties.• Good redundancy within trained teams, can replace team member if missing or fails to respond to call-out.• Matrix based training needs assessment• Competence based assessment system to assure training effectiveness• Recording and re-testing of competencies and reappraisal of training needs regularly.• Independent audit of emergency management training and capability

Figure 10-15 CMM processes observed at exercise GA

Staffing	Attention has been paid to the process of selecting an appropriate number and composition of staff to ensure that the site risk can be addressed at any time. The call-out standards set are risk-based, and frequently achieved in practice and real incidents. Technical response staff are selected on their professional competence, and the site emergency services are staffed in accordance with sound professional practice and the risk requirements of the site.
Communications	This process is well supported by secure and backed-up technology. The whole site and workforce are part of the wider emergency communications system, and the warning type has been based on the risks on the site. Some of the human components of the communications system require further training and alignment, to ensure that the correct incident information is provided through the display boards, to the rest of the EMT.
Work environment	The process of equipping the emergency management team with the necessary facilities and tools to manage the range of risks on the site has been managed well on this site. The latest appropriate technology is employed in the ECC and on-scene to provide full support to the emergency management staff. The fixed and mobile facilities and equipment on this site are of the highest international standard, and enable the EMT to cope with the full range of possible incidents.
Training and development	The process of training and developing staff to consistently perform the tasks required of them is described within the policy documents of this organisation, and proven through interview and observing an emergency exercise. Training is based on the needs and risks of the site, is managed in a sustainable way and recorded. The efficiency of the training programmes is also measured and monitored. Technical response staff are trained to the appropriate professional standards, and liaison and train with their counterparts in the external emergency services.
Workgroup development	This process aims to strengthen the workgroups or teams by ensuring that each incident experience is logged and recorded and the knowledge and experience is preserved in a format which can be used to enhance future performance. The aim is also to increase the intra-dependence of the team, and reduce dependence on other groups as far as possible.
Performance management	There is a sound level of feedback and learning at this site, and the lessons from an incident or exercise are logged, analysed and action plans drawn up to implement the changes. The emergency management system is well resourced to make the necessary changes based on performance.
Competency analysis	Response tasks have been analysed with respect to the knowledge, skills and abilities required to complete them. These competencies are recorded and are used to build the training and development programme. A named individual in the organisation is given the responsibility for this process.
Workforce planning	Ties the staffing issues to risk assessment and future development, and hard-wires any change in the plant or site, to a change in the emergency management system to ensure that adequacy of response is always maintained. This process should also consider changes outside the site which alter the requirements for the management of any incident.

Figure 10-15 (continued) CMM Processes observed at GA

Quantitative performance management	This process involves the setting, recording, monitoring and assessing quantitative targets for performance in certain tasks. It is important that targets are not just set and left stagnant, but are monitored and adjusted to reflect changing circumstances. Targets should be ultimately risk-based, and consistent failure to reach a target should trigger analysis of performance and changes to the task, training or hazard.
Participatory culture	As the next level of communications and coordination in an organisation, the process of participation ensures that there is a two-way communications channel between the workforce and the management. Meetings every 10 weeks allow all employees to voice any safety or risk concerns they have, and all suggestions are dealt with through a formal process with is logged, tracked, actioned and fed back.

10.2 Programme for Expert Validation Panel meeting.

Programme for 28th February 2003

Ecotechnology Bldg 37, central conference room.

09.00 – Set up room and PowerPoint, ensure coffee has arrived & flipcharts.

10 – 10.30 Welcome and introduction – Prof. JE Strutt

10.30 – 11.15 Presentation 1- research background and model
- Brian Jones

11.15 – 11.30 Coffee

11.30 – 12.00 Presentation 2 – Methodology for scoring and assessment – Brian Jones

12.00 – 12.45 Questions and discussion of Presentation 1
Discussing the method for converting the model & data used. Questions to kick-start- opinions on use of emergency exercises as indicators (COMAH and LA), EPs and their usefulness, any other methods. Round table.

12.45 – 13.45 Lunch

13.45 – 14.30 Group discussions of Presentation 2

Distribute flip charts & pens, split into two groups:

a) Jeremy & Helen, Ed, (& Mark)

b) JVS, Les & Ian

14.30 – 15.00 Summary of group of discussions

Each group has 15 minutes to summarise main points indicating:

additions, subtractions to indicators/processes/levels. Suggestions for assessment methodology. AOB including other uses, info they would like to see to assure them of technique.

15.00 Closing comments and thanks.

15.30 Car arrives for OCTO

10.3 Pilot interview transcripts

This note summarises the proceedings of three meetings held by OCTO and Cranfield University for the emergency planning and management project. The meetings were with a MAHI Pipeline operator (1), Constabulary A (2) and Fire Service A (3). Helen Shannon (HS) of OCTO and Brian Jones (BJ) interviewed the following persons representing their respective organisations:

- JH– Emergency Planning Advisor (1)
- – Pipeline Network Manager (1)
- Inspector - Emergency Operations (2)
- Inspector - Emergency Policies (2)
- Divisional Officer (3)

Key issues are identified in bullet point form, under the relevant meeting title.

PIPELINE OPERATOR MEETING

- Pipelines currently regulated under the Pipeline Safety Regulations. HSE is the official regulator. The issues of testing / exercising these plans, and charging for the tests have been omitted from the regulations. Reason was to await the implementation of COMAH (1999) and attempt to issue a blanket recommendation for the exercising of all emergency plans, COMAH & PSR. HSE has not yet made that recommendation concerning PSR.
- The point is raised by Pipeline operator 1 that the only legislative duty of a Local Authority to plan for a major incident is in the Cardiff Judgement, which is based on case law and states that if there is a plan in place, it must be capable of adequately fulfilling its role. BJ adds that secondary to this Local Authorities have a general 'duty of care' to their constituents, under which the preplanning for emergencies is usually considered.
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- HS stresses that HSE are interested in the adequacy of the plan, and do not expect that each authority should respond in a textbook fashion to any incident which may occur. The difficulty in defining and measuring preparedness is recognised.
- Issue of HSE assessing and commenting upon the effectiveness and contribution of the Emergency Services is political, as Em. Services and County Emergency Planning are under the Home Office guidance, and Industry is under HSE guidance.
- Pipeline operator 1 as an operator expresses concern at the disparity amongst Local Authorities in their styles and types of emergency planning. Different Local Authorities perceive Pipeline operator 1's response to be different, whereas in reality it is the same for each of their pipelines.
- Roles & Responsibilities, terminology, command structures and modes of operation all differ between different LA's and emergency services regions.
- The primary objective of Pipeline operator 1's response in any incident is to protect life.
- The Pipeline operator 1 system of call-out is illustrated in other documents and it is stressed that it is uniform for all responses. A number of LA's have

not recognised this response in their emergency plans, and have imposed a separate response structure on Pipeline operator 1. Pipeline operator 1 will follow their own procedures in event of an emergency.

- Taking this into account, Pipeline operator 1 exercise the same initial response for ANY leak report, and so practice it many regularly. This situation is similar in the case of many operators, who regularly respond to alarms and activate their emergency control centres on almost a daily basis. In these circumstances, it would be difficult to justify a regulation (COMAH or PRS) which demanded the testing of these aspects.
- It should be the responsibility of the Pipeline operator 1 engineer to identify the safe areas in a leakage from their network. The Emergency services do not have the necessary training or equipment to diagnose the extent of a leakage. Pipeline operator 1 are not capable, or responsible for identifying leaks from other operators. This is beyond the capabilities of their equipment and training.
- HS defines the major difference between an Offsite plan for a chemical plant, and a plan for a pipeline is that the epicentre of the chemical plant incident is defined, whereas the pipeline incident could have occurred anywhere across the route spanning a geographical region. (SEE DIAGRAM)
- BJ questions whether Pipeline operator 1 has the technology to detect leaks in their system by pressure indicators. PW responds that the pressure of system depends upon how many consumers are being served at one time. If a large consumer comes on-line, there may be a sharp decline in pressure, and so pressure sensors would not be useful in detecting leakage.
- JH informs the meeting that the Gas Management Safety Regulations demand a yearly testing of the emergency plan. (Under COMAH only one plan is required to satisfy whatever different regulations may be in place, so why not one test satisfies all? -bj) JH is concerned that the LA Emergency Planning is a separate issue, and therefore should be tested under a different regulatory framework to the Operators response. If the LA confuses the mandates of the parties involved, introducing new procedures and alien concepts, the other authorities will have a low level of ownership of the plan, and not use it to maximum potential.

It is considered important to draw the distinction between Pipeline Incident Response and Emergency Response. Both require testing & regulating, but separately and in different ways.

Police Meeting.

- The 'A' Constabulary has three levels of control – bronze, silver & gold. Bronze is the operational command, and is lead by an officer with the minimum rank of inspector. The location of Bronze will be as close to the scene as is safe. Silver is the tactical command, and is located at the safest, most convenient district police station (DPS). A is a reasonably compact county, and so the DPS's are never very far from conurbation. Fire, local authority, ambulance and the operators' representatives are present at silver, and sufficient communications are available to enable links with bronze and other locations. The fire brigade response is led from

the scene, and so a liaison officer is all that is required at silver. A command also included a location known as the Emergency Services Reinforcement base (ESRB) which was usually located at the nearest fire station to the incident. Its role was similar to silver, but the location was inconvenient and had poor communications links, so was not fully used in the event of an incident. In the new plan, ESRB is a resource muster & holding point.

- Gold is the police strategic command, and is rarely used. It is located at the County Police HQ in Atown, and lead by an officer of Assistant Chief Constable or higher. It would be attended by the Local Authority Chief Executive, senior staff from the other emergency services, PR representatives and appropriate persons from Central Government and the regulator. The police have an overall co-ordination role in the incident.
- The District Offsite Emergency Centre (DOSEC) is usually owned by the Local Authority. This causes some minor confusion in terms of co-ordination of the staff operating from that centre, and what level of control it should represent. This role is being redefined in A in current revision of the Major Incident Plan.
- Unless a guarantee is received from the Fire Brigade that the incident site is safe, the police will not send an officer there.
- It was stressed that once the emergency phase is finished, then the role of the emergency plan is finished. Rehabilitation and Reconstruction of property and communities should be taken care of by the local authority, with necessary investigations and reports taken care of by the responsible services as appropriate.
- The Police were keen to stress that their response to an incident is primarily to save life, and so many of the procedures which form part of that response are performed and practised by officers every day throughout the course of their duties. Performing exercises for all the emergency plans would result in a high level of duplication and unnecessary expense.

- The police do not see the County Emergency plan as a working document. It is seen as a summary of the Incident procedures of all the services involved, and part of its purpose is to illustrate to the regulator that the necessary planning has been carried out. The plan is too large and verbose to be referred to in an incident for guidance, so the police have an A5 booklet describing their Major Incident Procedures in a clear and concise format.
- HS suggested a scenario where the saving of life had to be prioritised between locations A (where there was little chance of the victims living through the ordeal) and location B (where there was increased chance of the victims living through it). The question of who would make that decision to prioritise was raised. The police responded that it would be a Silver control level decision, made jointly by the leading police, fire and ambulance officers with the Local Authority. If there was disagreement, then the Gold level control would be consulted and the basis of the decision would have to be outlined in policy and justified.

- 'A' Constabulary has an Emergency Planning Resource Group that has been found to be a useful interface between the organisations. The presence of this group is considered to be an indicator of best practice.
- The information gained from the interviews with the police, fire service and operators has released information and perspectives which could not have been obtained from reading the plan alone. This is an important point to make to HSE.
- The police consider the Home Office Publication 'Dealing with Disaster III' to be their target performance level for emergency response, and are happy that they satisfy the requirements in that document.
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- **Fire Brigade Meeting**
- The fire brigade plans and procedures have to be flexible enough to deal with major or minor incidents. A great deal of their response strategy is based around the experience of the officers in other incidents, and what actions they consider appropriate.
- The standard Chemical incident response is to get the officers to the scene safely. They can then achieve their aim of preserving life & the environment. The judgements about the safety of the officers will be based around advice from their control centre, who will seek specialist information from chemical data services such as CHEMSAFE and CHLORAID, in addition to telephoning local sites for assistance and advice. The appliances are equipped with Draeger Gas Tubes for diagnosis of several types of gas, and the officers have three levels of safety equipment from PPE to full gas-proof suits and BA.
- The proportion of Industry that is cutting the resources of its emergency response teams is detrimental to the quality and speed of service which they can provide, and adds increased pressure on the local fire brigade to respond.
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- The Fire Brigade system of calling in appliances and resources from other regions (known as draw-down) enables them to access a vast number of vehicles and officers. 'A' Fire Brigade has the capability of getting 38 appliances with crews, and the largest foreseeable incident would require 30 appliances.
- HS observed that the Pipeline maps included in the plan do not use contour lines, only spot heights. This is agreed to be a potential problem, and noted for report.
- The Fire brigade are not responsible for the decontamination of casualties. They have decontamination showers for the purpose of cleaning their officers, who will be in protective clothing. The equipment is not suitable for use on persons who are not wearing protective clothing. It is therefore the responsibility of the ambulance service to decontaminate casualties.
- Fire Brigade performance standards are summarised in an attendance target figure. Postal regions are given a code, according to the value of property located in that area. 'A' requires a response of 2 appliances within 5 minutes and a 3rd within 8 minutes. 'B' requires an appliance within 5 minutes and a 2nd within 8 minutes, 'C' requires one appliance within 8-10 minutes and D requires an appliance within 20 minutes. 88% of 'A' Constabulary is category D, and there is a further category of Remote

Rural, which is a longer response. Areas of special risk may be designated a higher initial response. These are nationally applied standards.

- The Hazard Briefing mentioned in the plan is a short message to the crew informing them of the level of safety equipment required, and the nature of the hazard. A Hazchem response is usually carefully considered and executed, in contrast to a fire response, which can be dealt with rapidly, within the procedural envelope and based on previous experience of the officers.
- A more user friendly and incident-hot use version of the emergency plan might be useful, but would require further research on the best way of achieving this.
- A further performance standard of the fire response could be the time taken to get the knowledge to the site.

10.4 Practical recommendations for exercise design, conduct and observation and emergency plan design

This section presents a set of recommendations for improving emergency planning and exercising. Other texts, reviewed and discussed in this thesis, provide guidance on emergency plan construction and emergency exercise conduct. The objective of this section is to bridge the gap between what is regarded as best practice, and the standard of emergency management that has been observed over the period of this study. The aim of these recommendations is to highlight the common areas where current industry practice in the UK deviates from the recommended best practice.

10.4.1 Recommendations for emergency exercise design

Exercises must be designed to facilitate learning. Motivation for exercising should be learning and development, rather than satisfying regulations. There should be defined exercise objectives, means of measuring the success of those objectives and established structures through which the lessons from the exercise can be learned and used. The majority of exercises reviewed for this study concentrated time and effort on preparation and implementation, but spent hardly any time on learning. Adopting a concept of 'value' in exercising would ensure that for every hour or pound invested in the exercise, there should be a measured outcome and benefit. Exercising is a cost-effective means of learning, if correctly structured and applied.

The design of exercises should involve or consult each of the parties who will be involved in the actual exercise. A number of operational staff involved in the various exercises observed for this study likened the experience to performing in a circus. They felt as though they were going through a choreographed act for the benefit of the observers. Unless the participants feel that the exercise is an appropriate learning medium, contribute to the planning and feel ownership for the outcome, then they are unlikely to pay much attention to the lessons from the experience.

10.4.2 Recommendations for emergency exercise conduct

Some of the exercises that were observed for this thesis showed an unrealistic attitude towards the time constraints of, and precision and decisiveness required in, a real incident. The offshore industry and some of the nuclear operators in the UK manage to bring this aspect of realism and urgency into their exercises by strict time management, rapid development of events and basing the exercise on a real sequence of events. A well researched, well planned and meticulously implemented exercise is likely to invoke a realistic response in the participants, and therefore recreate a likely response and learning environment.

While realism is important to emergency exercises, it is also important to recognise that the participants have limitations as humans. In the exercises observed for this study, while no problems were directly experienced, the organisations did not formally account for ethical considerations, measurement of stress in participants, and the realism of the demands they could place on their staff. While the majority of the organisations involved paid due attention to the refreshment and personal comfort of their exercise participants, it was necessary to draw this crucial matter to the attention of a small number.

10.4.3 Recommendations for exercise observation

It is critical that the exercise is planned with observation and measurement in mind, as without this forethought it can be difficult to document and record events for further analysis and learning.

Rules for observation techniques and methodology can be found in a variety of psychology texts; however it is most important for the observer to research the scenario in preparation, maintain meticulous records and keep a low profile during the exercise and participate fully in the debriefing session. Debrief sessions can also reveal the unobservable aspects of the exercise, which include interpersonal characteristics of the participants, subtle technical points and tacit knowledge within the organisation. In addition to debrief sessions, interviews with participants can also augment observer's results.

10.4.4 Emergency plan design recommendations

Extrapolation of a small incident emergency plan for use in a larger incident must not be accepted without more detailed examination of the issues and consequences involved. Full risk assessment is the only way of ensuring that the plan will enable the organisation to cope better with the circumstances.

Testing of the emergency plan can be part of the exercise regime schedule, but should not make up the entire exercise regime. Exercises can be beneficial for training purposes, and the emergency plan can be communicated to, and tested by staff without the use of full exercises.

Finally, a plan is not a static document, and should be adapted and changed in line with the results of a response, as well as being used as a guide for the response. Updating the plan using the experience gained in an exercise or incident (on-site or in line with best industrial practice or experience) is an important knowledge storage method, and will help ensure the relevance and validity of the plan.

An emergency plan should be structured and presented to make the necessary knowledge available to the reader, and guide their course of action in a direction that best addresses the risk. There is no ideal example of a well structured and presented emergency plan, it should be appropriate to the hazard that it is designed to protect against.
